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"Intra-Theater Logistics Distribution in the CENTCOM AOR"

October 2004

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CONFLICT OF INTEREST

Conflicts of interest did not become apparent as a result of the Panel's recommendations.

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6. AUTHOR(S)

Study Chairs:
GEN David M. Maddox (USA, Ret.), Dr. Marygail Brauner

Panel Members:
Mr. William S. Crowder
Mr. Richard Ladd
LTG Leo Pigaty (USA, Ret.)
GEN Leon E. Salomon (USA, Ret.)
VADM William Hancock (USN, Ret.)
LTG Charles Otstott (USA, Ret.)
Mr. Donald R. Quartel
Dr. David Schrady (Government Advisor)

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)

Executive Secretary
Army Science Board
SAAL-ASB
2511 Jefferson Davis Highway
Arlington, VA 22202-3911

8. PERFORMING ORGANIZATION REPORT NUMBER

N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

HON Claude M. Bolton, ASA(ALT)
GEN Paul J. Kern, CG, AMC
LTG Claude V. Christianson, DCS G-4

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13. ABSTRACT (Maximum 200 words)

In response to Army experiences in Operation Iraqi Freedom, the Army Science Board was tasked to investigate: 1) Forces for Theater opening and initial logistics operations; 2) The proposed Deployment Distribution Operations Center; 3) Asset in-transit visibility and management; and 4) Water production, storage, transport, and chilling on the battlefield. Each of these four major topics included numerous subtaskings.

The study generated many specific recommendations for improving in-theater logistics distribution, with the major recommendations including: 1a) Revise doctrine to codify the distinction between Joint theater-level and Army/Land Component logistic responsibilities, recognizing the need for a Joint theater-level Logistics commander to direct and execute the theater-level logistics tasks; 1b) Develop a Joint Theater Sustainment Command for assignment to Combatant Commands; 2) Implement useful practices of other services; 3) Complete a thorough business-based cost/benefit analysis of RFID before spending any more money on it; 4) Fix the chlorination problem of ROWPU (Reverse Osmosis Water Purification Unit) produced water.

The study proposed specific force structures for both Joint theater-level and Army/Land Component logistics forces, identified specific practices of other Services that the Army should consider adopting, and identified promising water production technologies for further development.

14. SUBJECT TERMS

Logistics, Logistics Support, OIF Logistics, Sustainment, OIF Sustainment, In-Theater Sustainment, LOGCAP, CENTCOM Deployment Distribution Operations Center, CDDOC, CDDOC Metrics, Asset in Transit Visibility, ITV, Logistics Technologies, Water, Reverse Osmosis Water Purification Units, ROWPU, ROWPU Water, Water Purification Technologies

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Intra-Theater Logistics Distribution in the CENTCOM AOR

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Intra-Theater Logistics Distribution in the CENTCOM AOR

Executive Summary

As a result of distribution problems encountered during Operation Iraqi Freedom (OIF), the Assistant Secretary of the Army (Acquisition, Logistics, & Technology) asked the Army Science Board to conduct a study covering intra-theater logistics distribution. The study sponsors were ASA(ALT), HQDA G-4, and AMC. This study was conducted by 10 ASB Members, Consultants, and Government Advisors between November 2003 and July 2004. Concurrent with the Science Board study that addressed the issue once personnel, equipment, and supplies arrived in theater, the Army G-4 asked the RAND Corp to examine the same issue from an inter-theater perspective.

The terms of reference for this study focused on four major areas:

1) Initial forces/capabilities required for opening the theater and beginning initial sustainment.
    i. Assessing the adequacy of Army and Joint doctrine.
    ii. Examining other Services for more effective or efficient logistics distribution policies/procedures.
    iii. Evaluating the concept of creating a floating repair and/or supply capability afloat.
    iv. Examining the impact on Theater logistics associated with organic logistics capability in the 3rd ID, Stryker Brigade Combat Team, and modular brigades.
    v. Evaluating the impact of no LOGCAP being deployed before C+30.
2) Assessment of the newly created joint Deployment Distribution Operation Center, recommending whether the DDOC should be a permanent or temporary Theater capability.
3) Asset in transit visibility with specific focus on the use of radio frequency identification tags, and lastly
4) Production, Storage, Transport, and Chilling of Water on the Battlefield to include an assessment of current technologies for the production of pure water.

Recommendations and Findings

The first area lays out the requirements for joint and Army forces needed in theater opening and logistics operations. The discussion begins with a summary of GAO theater distribution findings. Based on those findings and discussions with theater-level and Army personnel, the case for a joint theater-level logistic function, doctrine, and command authority is articulated. The report outlines the joint organizational structure required for theater opening and logistics operations to include a deployment distribution operations center and a theater distribution center. Such organizations require a command element for intra-theater logistics and a joint theater-level logistics force structure.

The applicability for the Army of other services' logistics practices including supply, repair, and maintenance on land and afloat is reviewed. The review includes a discussion of the Air Force's Cargo Movement Operations System (CMOS). This system gives the Air Force visibility over materiel in the transportation pipeline and provides decision-makers with information to monitor

the dynamic arena of capability versus requirement in the mobilization, deployment, sustainment, and redeployment of forces.

This section of the report concludes with the development of a proposed Army/Land Component logistics force structure and discusses the impact of alternative brigade force designs. The report observes that other services use a scaleable and modular combat support package. Such a concept could be use in support of modular brigades. Additionally, the report examines the importance of civilian contractor support for CS/CSS services early in theater operations.

Recommendations for theater opening and logistics operations:

1) The Joint Logistics, Joint Integrating Concept (JIC) should identify and codify the distinction between the logistics functions performed at the joint theater level vs. the service component level.
2) Aggressively support the development of joint doctrine to define the functions, command relationships, and organizations needed to perform joint theater logistics functions and the subset required for theater opening.
3) Establish the doctrinal requirement to provide a joint theater level logistics commander to a theater-level commander when an operational mission is assigned.
4) Complete the development of a Joint Theater Sustainment Command (TSC) and its subordinate elements and put it in the Army Campaign Plan.
5) Activate at least two active component Joint Theater Sustainment Commands.
6) Develop the TOE of the Theater Opening BDE to consist of the elements of the mature TSC needed early.
7) Assign the Theater Opening BDE and Theater Distribution BDE along with other appropriate Service elements to the TSC.
8) Establish and resource at least two active duty Theater Distribution Centers to provide an initial capability and consider potentially one per theater.
9) In developing the Joint Theater Sustainment Command, the Army should recommend the placement of the DIRMOBFOR under the Joint Theater-level Logistics Commander or at least with tactical control by him.
10) The Joint Theater-level Logistics Commander should establish DIRMOBFOR-like commands for control and scheduling of all intra-theater sealift and ground transportation assets.
11) Take advantage of existing regional facilities established by the Navy in theater, and use the existing DLA contract relationships to satisfy a portion of the Army initial sustainment demand.
12) As part of the joint logistics process, collaborate with DLA and the other services to develop a Joint Warehouse Ship concept and acquire sufficient Warehouse Ships to provide initial sustainment.
13) The Army should implement a retrograde policy for reparables similar to that in place with the Navy and the Air Force to avoid build up in theater of items requiring depot level repair.
14) Establish a GS repair capability in theater...not as part of the theater opening package but as a sustaining element.
15) Evaluate existing USN/USAF repair facilities in theater and assess the potential to accommodate Army repair requirements in them.
16) Participate actively with Navy in developing Joint Seabasing CONOPS.

17) Do a cost/benefit analysis of providing GS repair capability afloat.
18) Take advantage of an investment already made by the Air Force in Cargo Movement Operations System (CMOS) rather than developing a separate Army transportation movement information system, expedite completion of current assessment of CMOS, and direct PM-TCAIMS-II to develop an implementation plan to field CMOS Army-wide.
19) Designate the portion of the Army Component Command/Land Component Command logistic structure that needs to deploy with the Joint Force opening forces to interface with it and commence early operations.
20) Review and modify various BDE/UA designs to standardize organic logistics capabilities.
21) Design Sustainment UAs to accommodate BDE/UA LOG capabilities shortfalls.
22) Apply a bottom up analytical technique, similar to the USAF Agile Combat Support methodology to determine required non-organic support elements. Tie to identifiable combat units with a goal of providing scaleable and modular combat support elements that are automatically associated with the various combat elements being developed in the evolving Modular Brigades.
23) Do not replace available LOGCAP capabilities with AC units.
24) Have LOGCAP in place, and allow early deployment of Team LOGCAP Forward to begin contract execution.
25) Provide for rapid mobilization of LOGCAP Support Unit.

Recommendations for the Deployment Distribution Operation Center:

1) Establish the JTOE and resource a DDOC for each CoCOM.
2) Assign a DDOC to the Joint Theater-level Logistics Commander who has the authority to direct actions.

The RFID and in-transit visibility is the third topic in the study. The application of tracking technologies and information technologies by the commercial sector and DoD is reviewed. The review is followed by a discussion of DoD RFID policy and implementation. The study has strong recommendations in this area.

1) The Army and DoD should purchase only industry-common RFID tags.
2) DoD and the Army should together conduct a thorough business case and cost/benefit analysis of the joint supply and transportation system, to include the requirement for interoperable IT systems, prior to any further purchase, implementation, or reconfiguring of RFID.
3) Based on business case and cost/benefit findings, develop funded BOIP, TTPs, and training programs for RFID

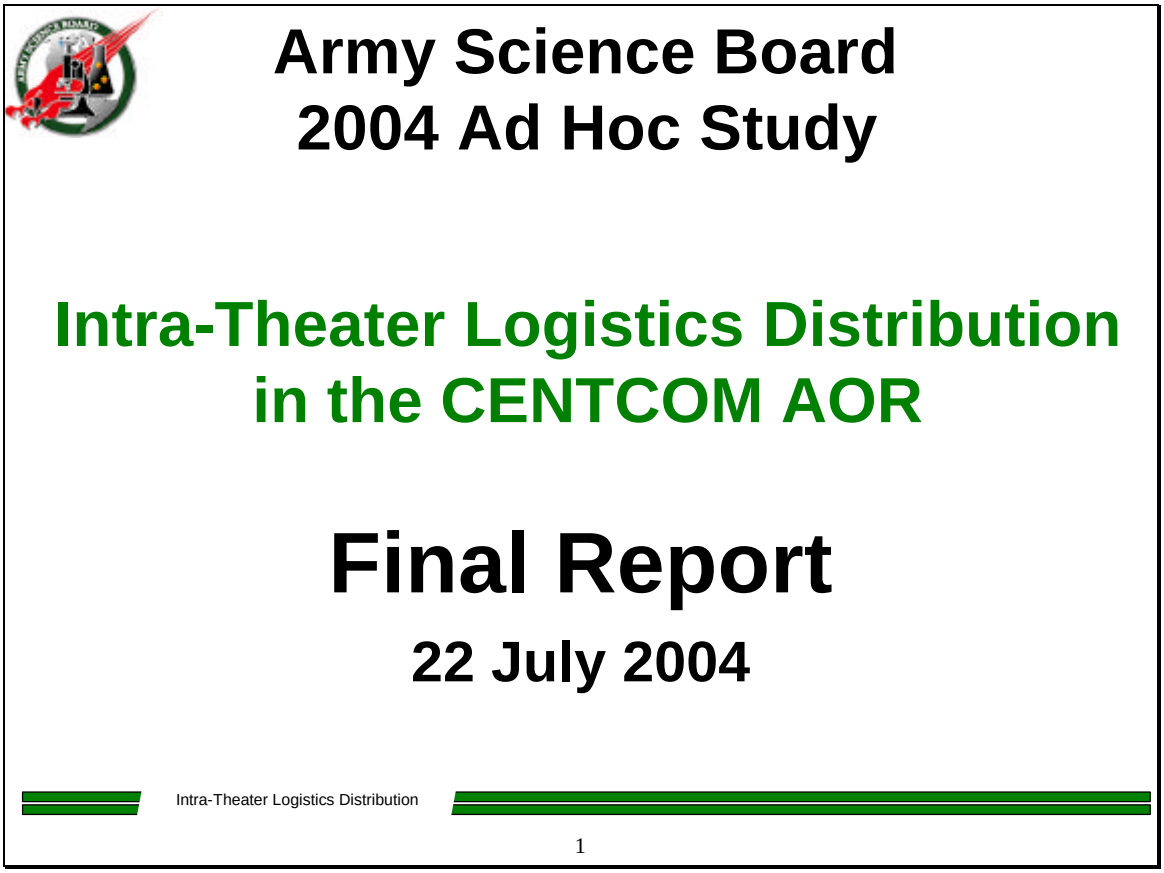
The last study topic is water production, storage, transport, and chilling on the battlefield. Before discussing future water production technologies, the report reviews water treatment and distribution systems to include reverse osmosis water purification units (ROWPU) and bottled water. Some commercial off the shelf water purification solutions are enumerated. The recommendations on water are:

1) Integrate new water purification technology (to reduce chlorine) into new ROWPU units
2) Purchase individual purifiers as part of soldier enhancement program.
3) Procure the new water treatment (with new purification technology) and distribution systems and align fielding plan to support Army modular initiative.
4) Investigate bottling water from ship board desalination systems as a required function in the Joint Warehouse Ship.
5) Pursue development of water from alternative sources and alternative water packaging initiatives.

Conclusions

To effectively open and begin logistics operations in a theater of operations and to preclude the problems encountered in Operation Iraqi Freedom, the following recommendations should be implemented:

1. Doctrine and Structure
   - Codify in joint doctrine the distinction between joint theater level logistics and Army/Land component logistics requirements and the need for a joint theater-level logistics commander
   - Document a Joint Theater Sustainment Command and assign to CoCOMs
2. Implement useful practices of other services
3. Don't preclude early use of LOGCAP
4. Complete a thorough business-based cost/benefit analysis of RFID before spending more money on it
5. Fix the chlorination problem of ROWPU water.



The Assistant Secretary of the Army (Acquisition, Logistics, & Technology) asked the Army Science Board to conduct a study covering intra-theater logistics distribution as a result of distribution problems encountered during Operation Iraqi Freedom (OIF). The study sponsors were ASA(ALT), HQDA G-4, and AMC. Concurrent with the Science Board study that addressed the issue once personnel, equipment, and supplies arrived in theater, the Army G-4 asked the RAND Corp to examine the same issue from an inter-theater perspective.

Study Terms of Reference

Study the challenges facing the Army in distribution of supplies and materiel to the Central Command Area of Responsibility and in future operations

- Forces for Theater opening and initial logistics operations
- Deployment Distribution Operations Center
- Asset in-transit visibility and management
- Water production, storage, transport, and chilling on the battlefield

This slide summarizes the terms of reference for this study. The scope focused on four major areas:

(1) the initial forces/capabilities required to open the theater and begin initial sustainment.
(2) an assessment of the newly created joint Deployment Distribution Operation Center
(3) an examination of asset visibility with specific focus on the use of radio frequency identification tags, and lastly
(4) an examination of the provision of water on the battlefield

Intra-Theater Logistics Distribution Study Organization

SA to Study Chairs
COL Bob Carpenter HQDA G-4

CO-CHAIRS

Dr Marygail Brauner (RAND) ***David M. Maddox (USA, Ret.)***

Bill Crowder	-	USA, Ret,	LMI
Bill Hancock	-	USN, Ret,	Logistics/Financial Consultant
Dick Ladd	-	CIV	Budget/Financial Consultant
Charley Otstott	-	USA, Ret,	Operations Consultant
Leo Pigaty	-	USA, Ret,	Logistics Consultant
Rob Quartel	-	CIV	Frmr Federal Maritime Commissioner, Supply Chain Information Technology
Lee Salomon	-	USA, Ret,	Logistics Consultant
David Schrady	-	USNPGS,	Professor OA

This slide displays the membership of this study group

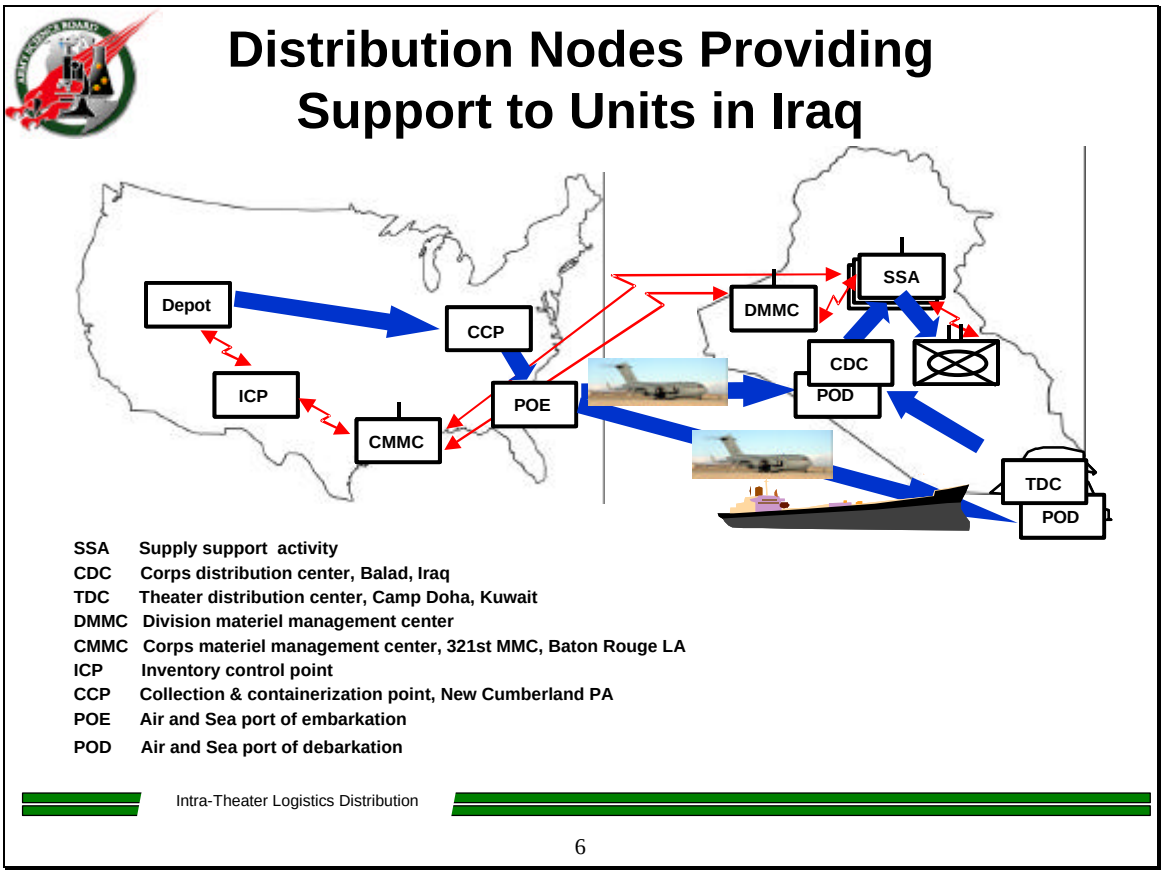
Study Input

NAME	ORGANIZATION	AREA OF EXPERTISE
• Malcolm Siegel	Sandia Labs	Water Technologies
• Tom Hinkebein	Sandia Labs	Water Technologies
• Michael B. Murphy	Sandia Labs	RFID
• Kenneth W. Plummer	Sandia Labs	RFID
• Jay Dusenbury	U.S. Army TARDEC	Water Technologies
• Jeffrey D. Fee	LTA	RFID
• MG Mortensen	CENTCOM J-4	CDDOC
• BG Radin	CFLCC C-4	TDC
• BG Stultz	CFLCC C-4 for Distro and Trans	TDC
• BG Levasseur	Commander CDDOC	CDDOC
• BG Fletcher	HQDA Deputy G-4	Theater Opening
• LTC Tim Thurmond	HQDA G-4	RFID
• LTC Jerry Thomas	HQDA G-4	Theater Opening
• COL James Rentz	HQDA G-4 OIF	Lessons Learned

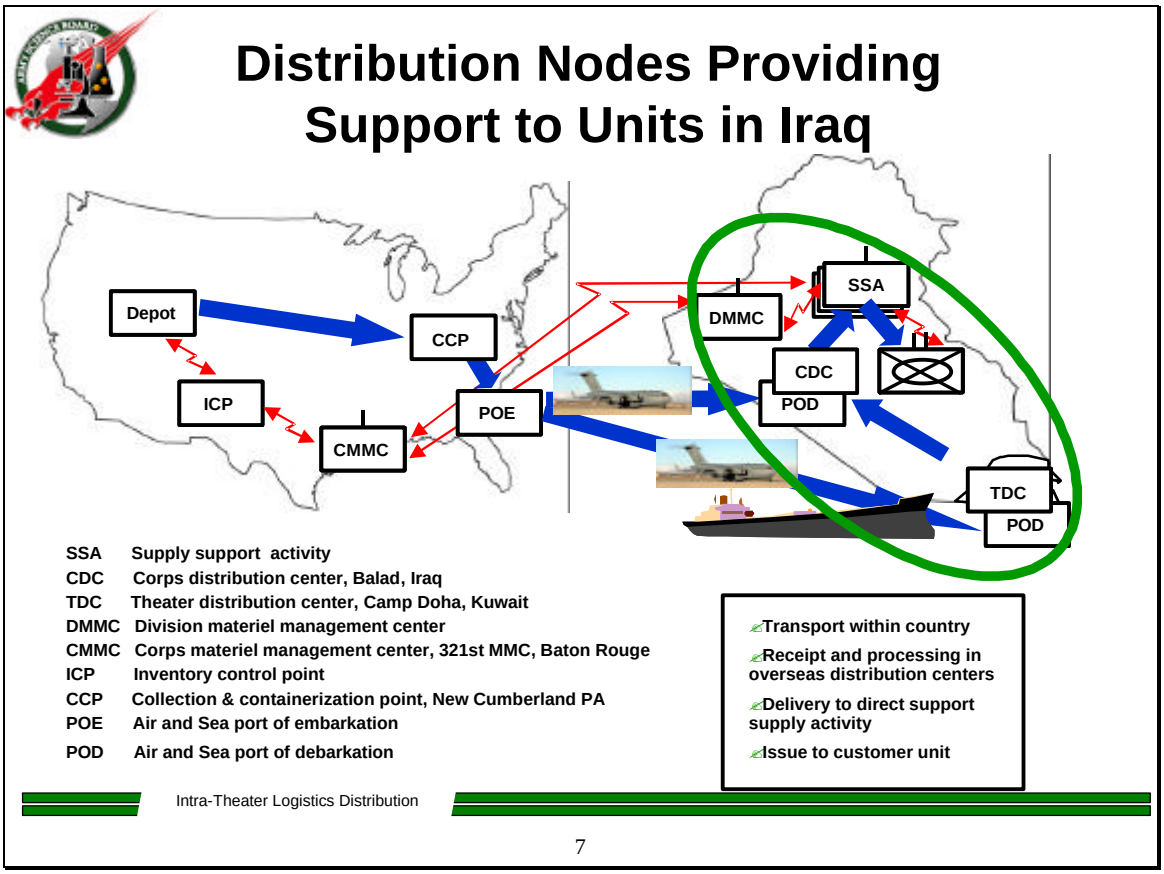
In the conduct of this study, the listed individuals were interviewed and provided input to the study.

Study Input

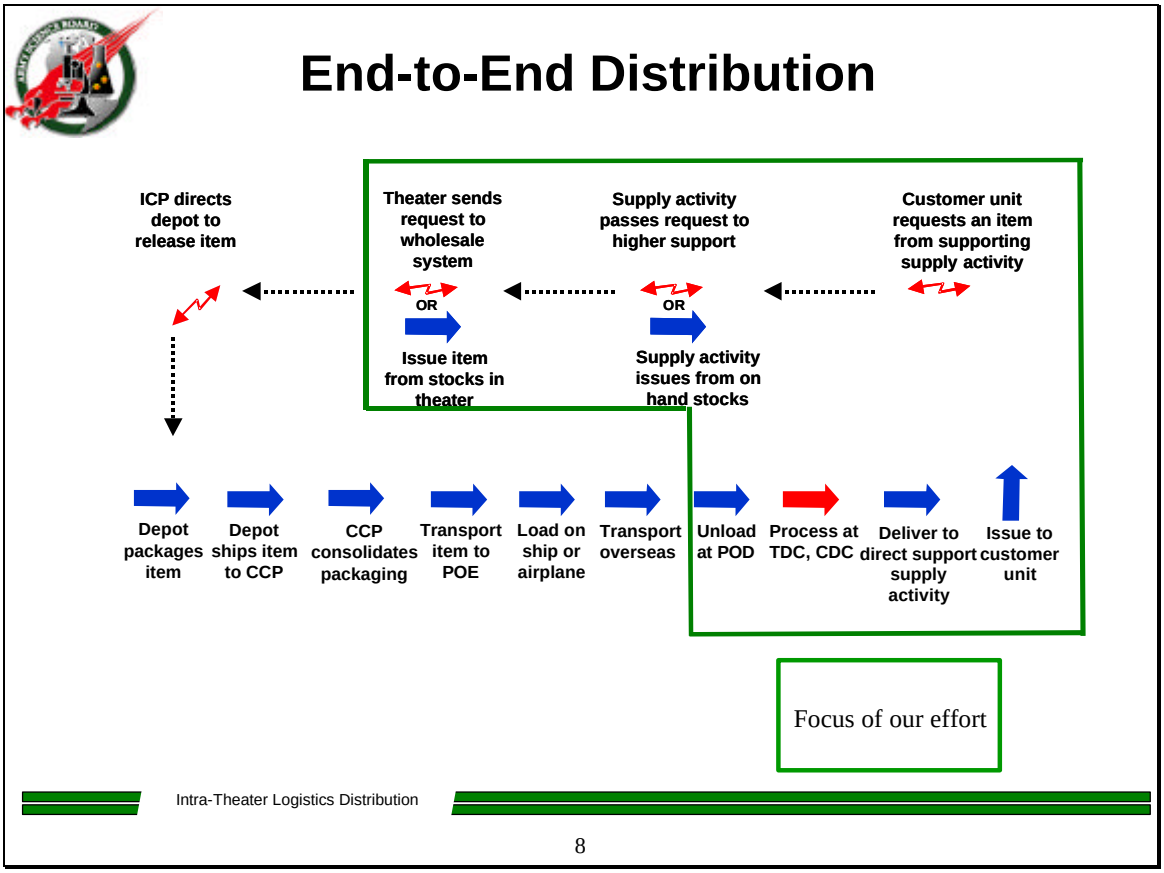
NAME	ORGANIZATION	AREA OF EXPERTISE
• COL James Lee	377th TSC OIF	Lessons Learned
• COL Clemons	CASCOM	Water Technologies
• COL Bill Pratt	CFLCC	OIF Lessons Learned
• Alan Estevez	OSD-ATL	RFID
• Tony Prince	OSD-ATL	RFID
• Rodney Herrington	Miox Corp	Water Technologies
• Bill Obermann	Miox Corp	Water Technologies
• COL Bruce Reilly	HQDA G-4	AC/RC Mix, Future Forces
• Vic Verma	Savi Technology	RFID
• David Stephens	Savi Technology	RFID
• Don Plater	HQDA G-4	JIC
• Lt Col George Lauve	HQ USMC	USMC Port Opening
• MAJ John Lawson	HQ USMC	USMC Port Opening
• Eric Peltz	RAND	OIF Lessons Learned
• Marc Robbins	RAND	OIF Lessons Learned



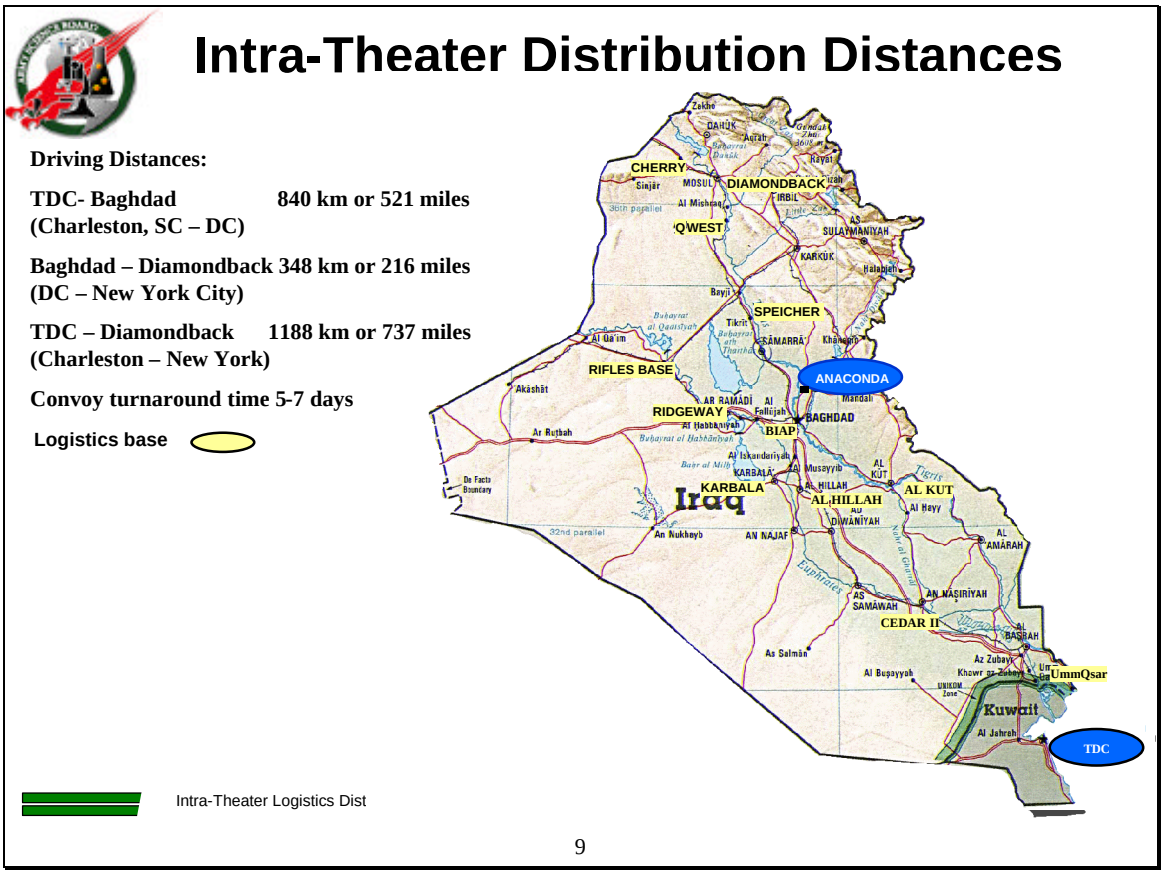
The key nodes involved in inter-theater distribution are displayed geographically on this chart.



The geographic area shown within the oval is the focus of this study.



This chart displays inter-theater distribution as a process with the intra-theater portion of that process contained in green. It is this latter portion that is the focus of this study.

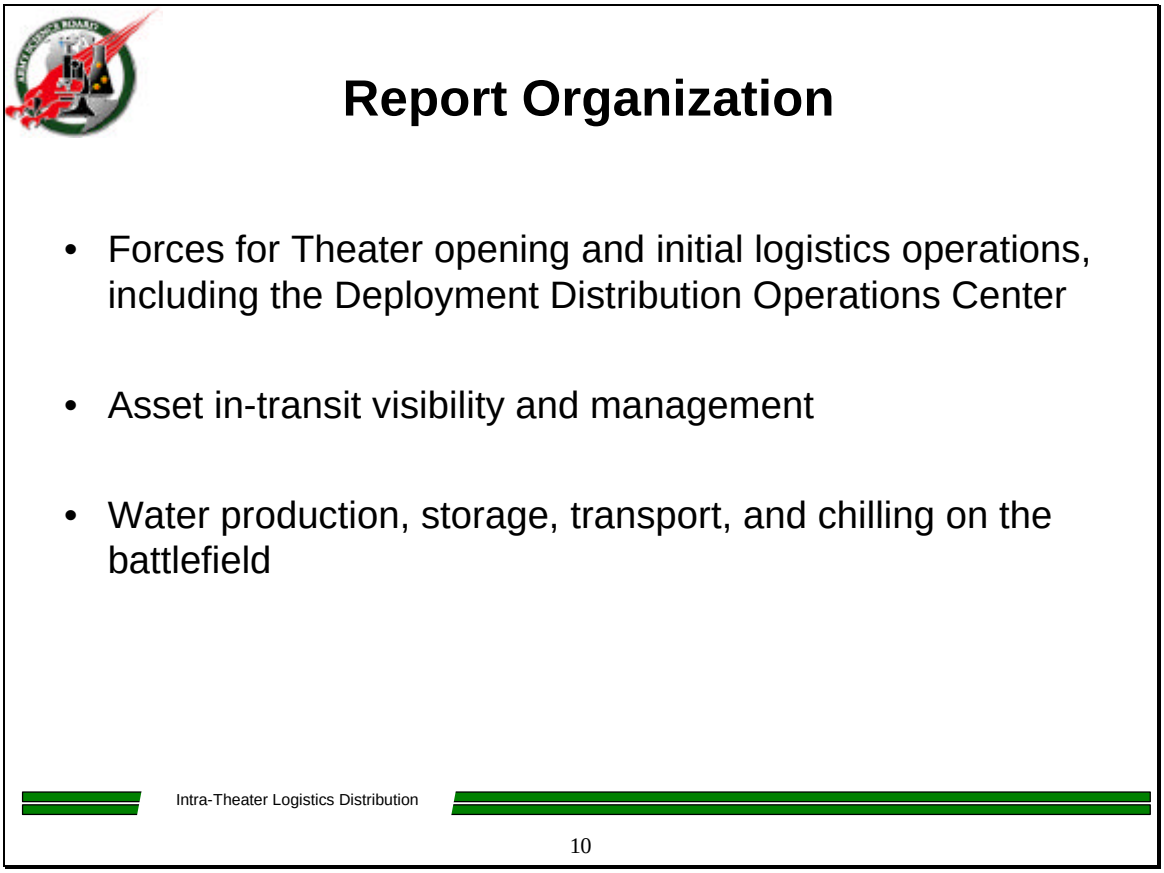


The distance from the Theater Distribution Center (TDC) to Baghdad is 521 miles or about the same distance from Charleston SC to Washington.

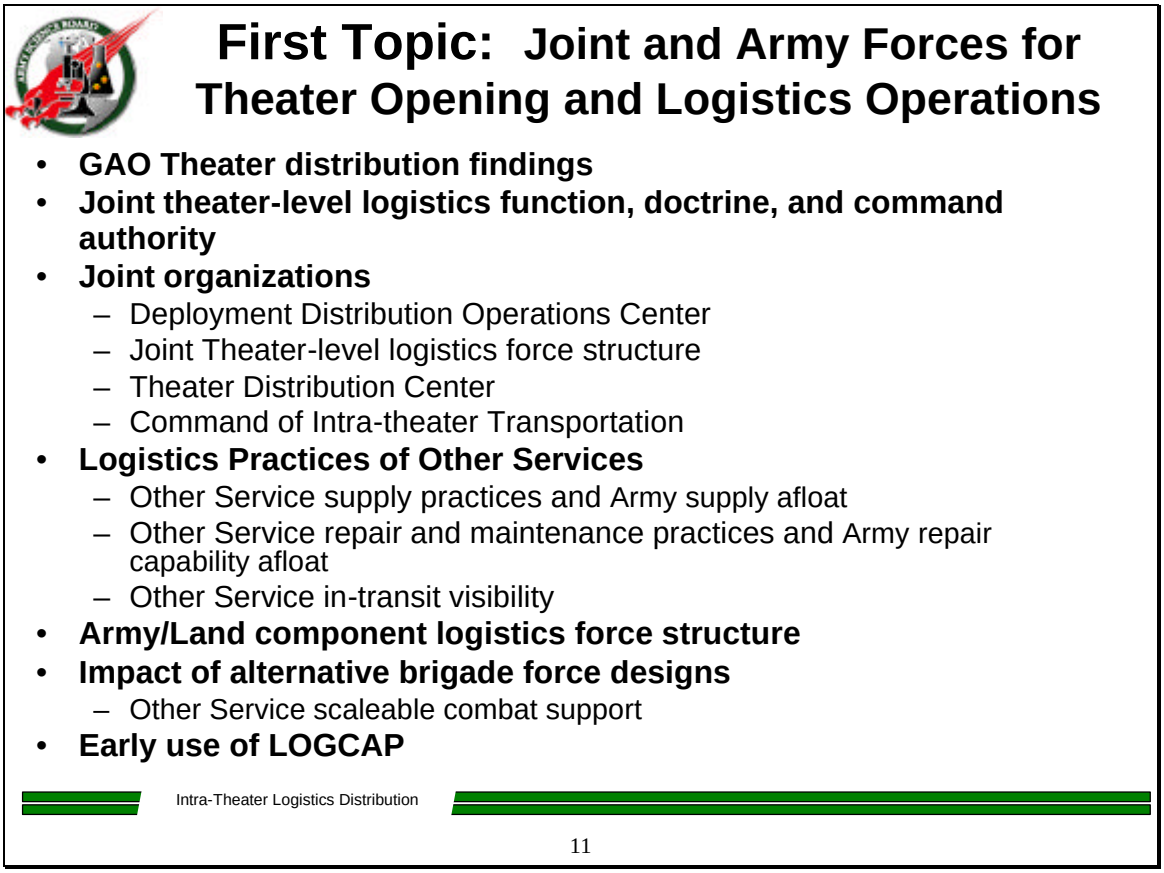
The distance from Baghdad to Diamondback is an additional 216 miles or about the same distance as from Washington to New York City.

This 737 mile trip is over sections of unimproved roads and subjected to improvised explosive devices and intermittent attacks.

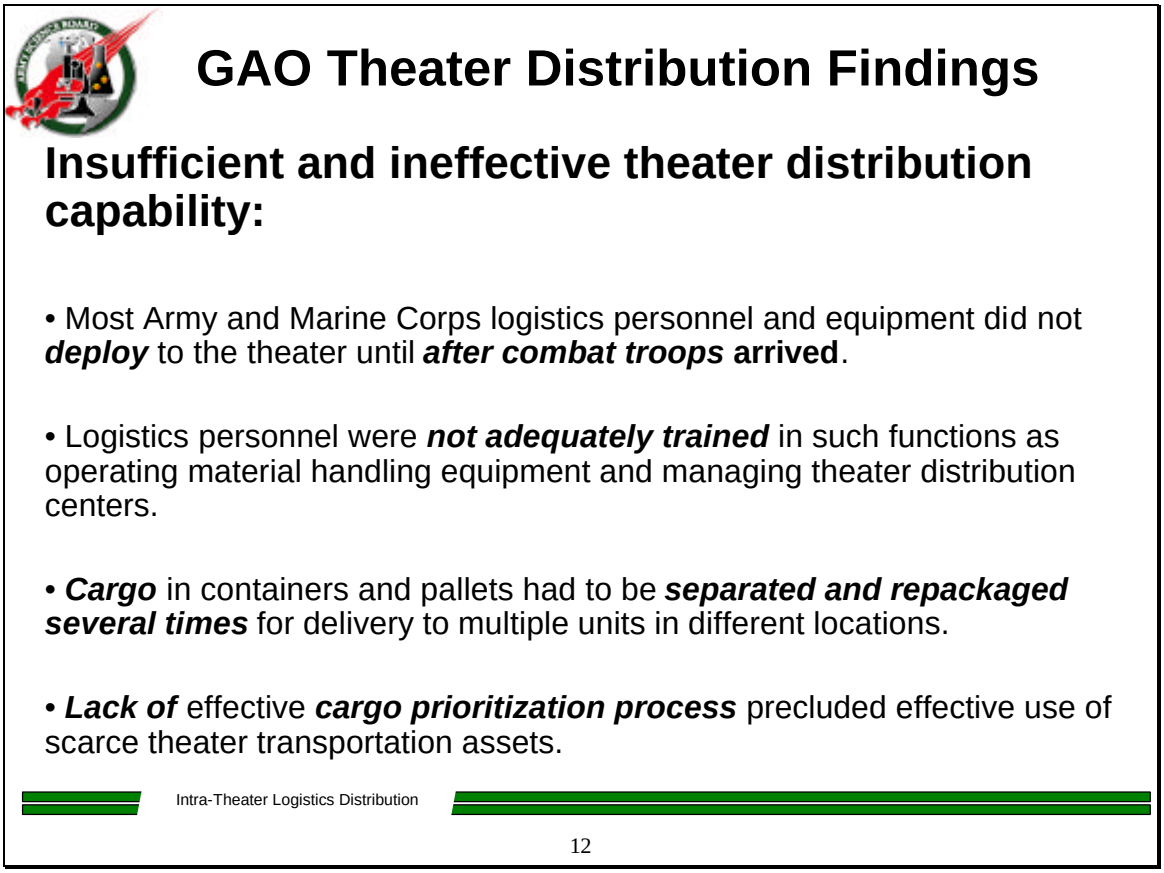
The turn around time is from five to seven days, requiring five to seven times the number of trucks than those required if it were a single day trip.



Our report will be organized into these three areas, consistent with the terms of reference



The first section will cover the logistics functions and organizations needed at the theater-level and will include discussion of the topics shown.



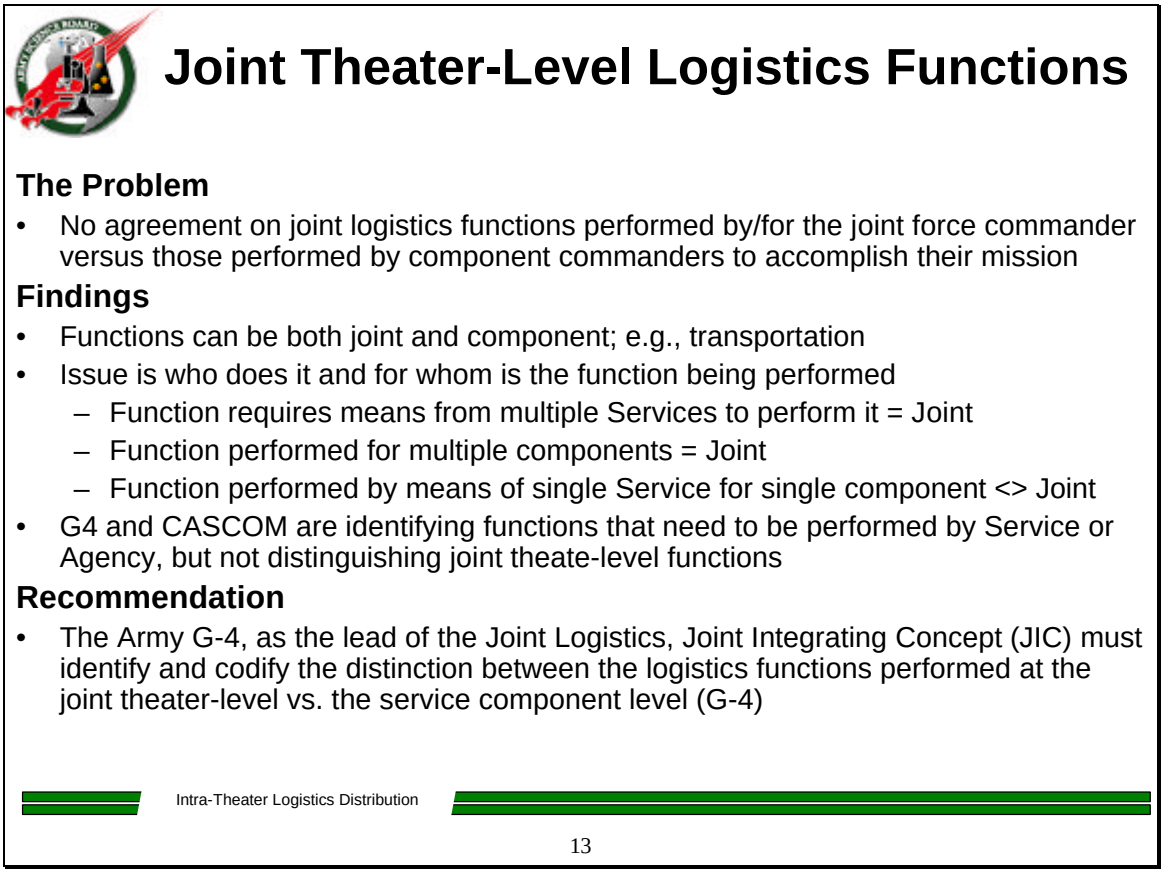
Insufficient distribution capability in the theater to effectively manage and transport the large amount of supplies and equipment deployed during OIF; e.g., adequate transportation assets (cargo trucks and materiel handling equipment) were not available.

For the first year, cargo arriving in shipping containers and pallets required separation and repackaging for delivery to multiple units in different locations.

Lack of an effective cargo prioritization process precluded the effective use of scarce theater transportation assets.

Most Army and Marine Corps logistics personnel and equipment did not deploy to the theater until after combat troops arrived, and, in fact, most Army logistics personnel did not arrive until after major combat operations commenced.

Logistics personnel were not adequately trained in such functions as operating material handling equipment and managing theater distribution centers.



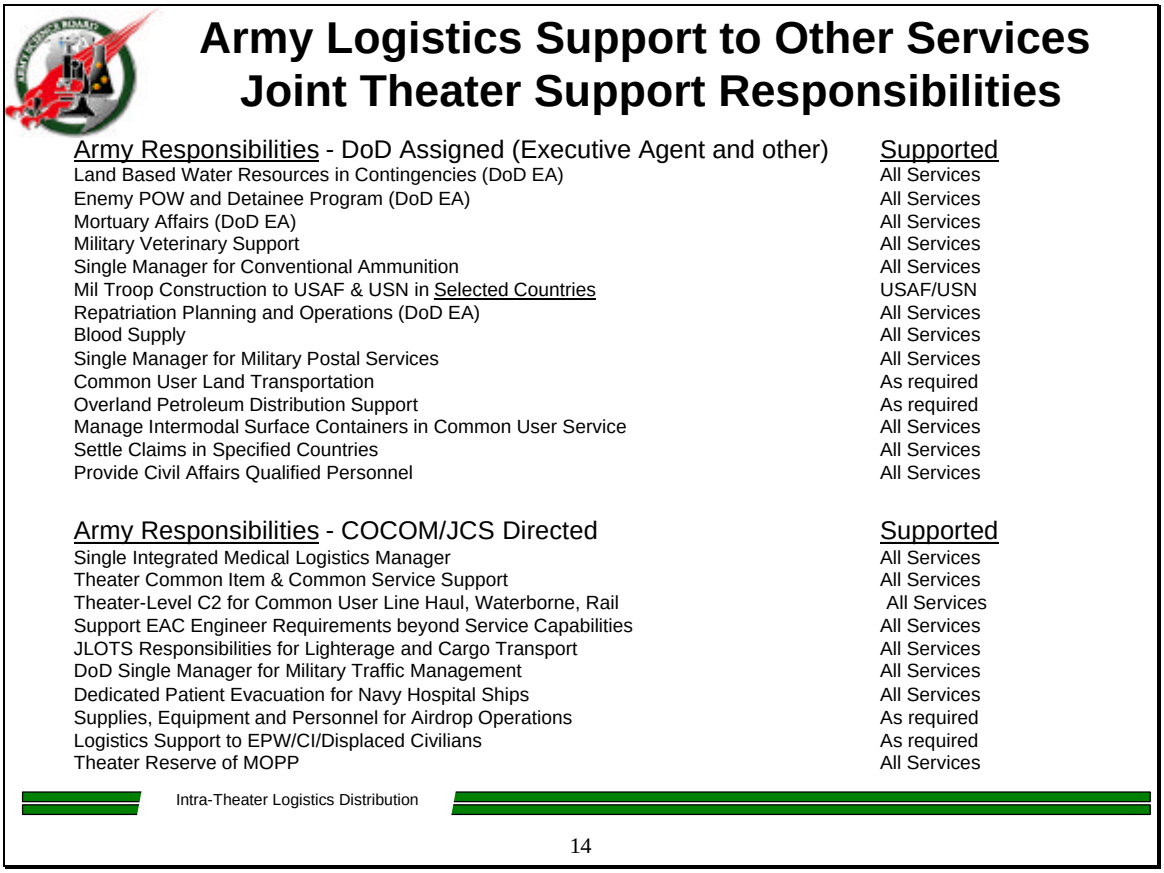
Joint Force Commander is responsible for determining the force required to accomplish the mission and the receipt, staging and onward movement of those forces to component commanders; the provision of adequate resources to component commanders to fight that force; and the retrograde from theater.

Joint Force Commander allocates geographic space of his area of operations (AO) to component commanders and retains space for theater-level operations (Joint HQ, APODs, SPODs, ISBs, staging areas, TDCs, theater-level depots, hospital, etc, with appropriate force protection).

Joint Force Commander must monitor flow of resources to the theater to adjust that flow.

Joint Force Commander responsible for operation of APODs, SPODs, ISBs, and the receipt of troops, equipment and supplies, movement of them to staging areas and theater distribution centers, and the onward movement to component commanders.

G4 & CASCOM have done considerable work in concepts as well as identifying & relating functional capabilities to potential providers and C2 COAs.



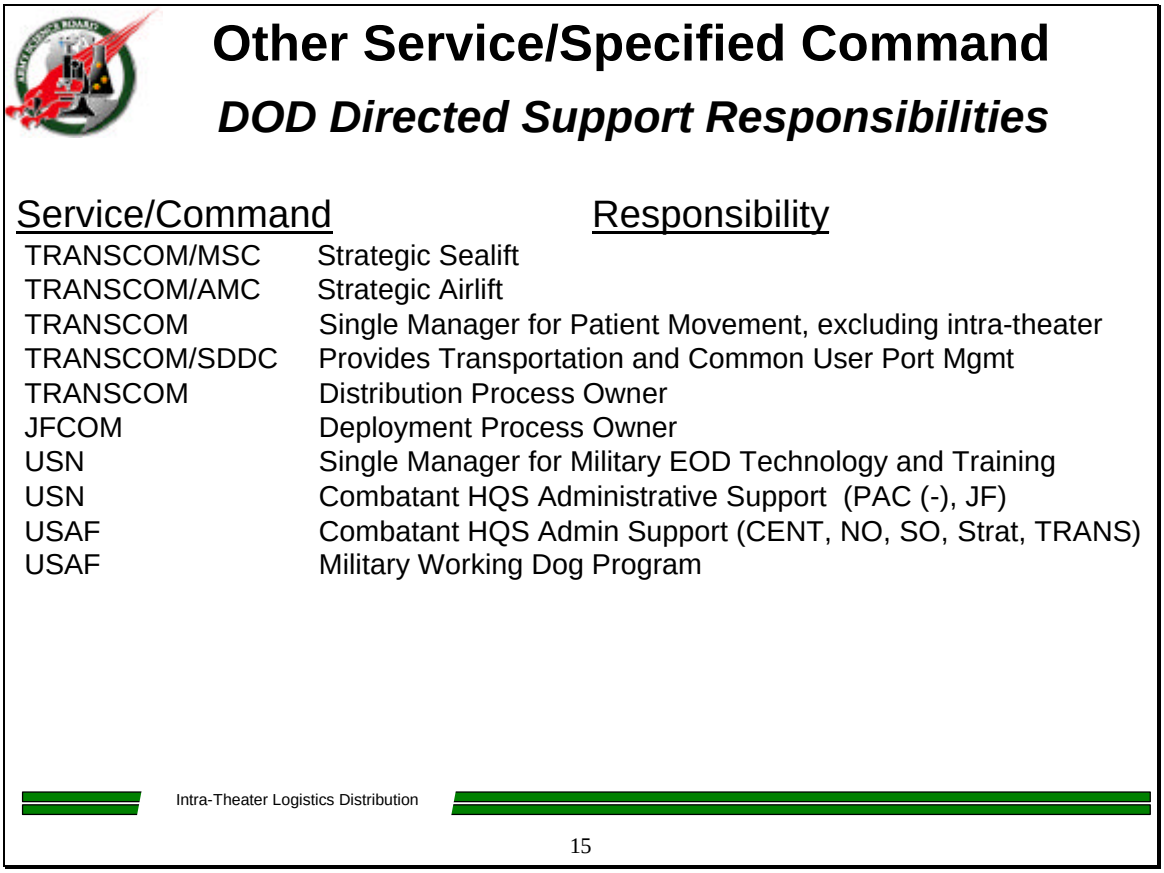
The Army has been tasked by DoD, JCS, and CoCOMs to provide logistics support to other Services and agencies. The list on this chart highlights them.

Authorities for Responsibilities

DoD EA for Land Based Water Resources in Contingencies (DoD Directive 4705.1 – 9 Jul 92)
DoD EA for Enemy POW and Detainee Program (DoD Directive 2310.1 – 18 Aug 94)
DoD EA for Mortuary Affairs (DoD Directive 1300.22 – 3 Feb 2000)
Military Veterinary Support (DoD Directive 5200.31 – 22 Aug 2003)
Single Manager for Conventional Ammunition (SMCA) (DoD Directive 5160.65 – 8 Mar 95)
Mil Troop Construction to USAF & USN in Selected Countries (DoD Directive 1315.06 – 26 Aug 78)
DoD EA for Repatriation Planning and Operations (DoD Directive 3025.14 – 5 Nov 90)
Blood Supply (DoD Directive 6000.12 – 29 Apr 96)
Single Manager for Military Postal Services (DoD Directive 4525.06 – 5 May 80)
Common User Land Transportation (DoD Directive 4500.9 – Change 3, 17 Nov 2003)
Overland Petroleum Distribution Support (DoD Directive 4140.25 – 25 Aug 2003)
Manage Intermodal Surface Containers in Common User Service (DoD Directive 4500.09 – Change 3, 17 Nov 2003)
Settle Claims in Specified Countries (DoD Directive 5515.8 – 9 June 1990) Kuwait – OPLAN 1003-98)
Provide Civil Affairs Qualified Personnel (DoD Directive 2000.13 -27 June 1994)

OTHERS - NOT SPECIFIED ON CHART

Combatant HQS Administrative Support (EUCOM, SOUTHCOM, Korea) (DoD Directive 5100.3 – 15 Nov 99)
DoD EA for Chemical Warfare / Chem/Bio Defense RDA Program (DoD Directive 5160.05 – 1 May)



Other services and agencies likewise have been tasked to provide support to other Services. Those taskings are shown on this chart.

Authorities

US TRANSCOM is the transportation manager for DoD, and is responsible for providing global transport in support of national security objectives (JP 4-01.3 – 9 Apr 2002) - **Strategic Sealift**; **Strategic Airlift**
US TRANSCOM Single Manager for Patient Movement, excluding intratheater (DoD Directive 6000.12 – 29 Apr 96)
US TRANSCOM Provides Transportation and Common User Port Management (JP 4-01 – 19 Mar 2003)
USN Single Manager for Military EOD (DoD Directive 5160.62 – 26 Apr 89)
USAF Military Working Dog Program
USAF - Combatant HQS Administrative Support (CENT, NORTH, SO, Strat, TRANS) (DoD Directive 5100.3 – 15 Nov 99)
USN - Combatant HQS Administrative Support (PAC (-), JF) (DoD Directive 5100.3 – 15 Nov 99)
JFCOM - Deployment Process Owner (DoD Directive 5158.5 – 12 Nov 2001)
TRANSCOM - Distribution Process Owner

These authorities should be the start point of determining the Joint Theater-Level Logistics/Support functions.

Adequacy of Joint Logistics Doctrine

The Problem

- Joint Doctrine is not current and does not clearly distinguish the theater opening/theater sustaining functions/tasks required at the Joint Force Commander level

Finding

- Twenty One Joint Logistics Pubs
  - Several need updating
  - Do not distinguish between joint and Service functions

Recommendation

- Aggressively support the development of joint doctrine to define the functions, command relationships, and organizations needed to perform joint theater logistics functions and the subset required for theater opening (G-4)

We reviewed the existing joint publications associated with logistics. Many are outdated and inconsistent with current operations. Of the 21 joint logistics publications, two of them are currently being combined and updated into one and three others are being consolidated and updated. The primary concern is that they do not distinguish between those functions/tasks which are performed by and for the theater commander from those performed by and for the component.

Adequacy of Joint Logistics Doctrine

Joint doctrine publications regarding theater-level logistics operations including theater opening:

- JP 4-0, Doctrine for Logistic Support of Joint Operations, 06 April 2000
- JP 4-01, Joint Doctrine for the Defense Transportation System, 19 March 2003
- JP 4-01.2, JTTP for Sealift Support to Joint Operations, 9 October 1996
- JP 4-01.3, Joint Tactics, Techniques, and Procedures for Movement Control, 09 April 2002*
- JP 4-01.4, Joint Tactics, Techniques, and Procedures for Joint Theater Distribution, 22 August 2000*
- JP 4-09 Joint Doctrine for Global Distribution, 14 December 2000*
- JP 4-01.5, Joint Tactics, Techniques, and Procedures for Transportation Terminal Operations, 9 April 2002
- JP 4-01.6, Joint Tactics, Techniques, and Procedures for Joint Logistics Over the Shore, 12 November 1998
- JP 4-01.7, JTTP for Use of Intermodal Containers in Joint Operations, 7 January 1997
- JP 4-01.8, Joint Tactics, Techniques, and Procedures for Joint Reception, Staging, Onward Movement, and Integration, 13 June 2000**
- JP 3-35, Joint Deployment and Redeployment Operations 7 September 1999**
-
- JP 4-02, Doctrine for Health Service Support in Joint Operations, 30 July 2001
- JP 4-02.1 , JTTP for Health Service Logistic Support in Joint Operations, 6 October 1997
- JP 4-02.2, Joint Tactics, Techniques, and Procedures for Patient Movement in Joint Operations, 30 December 1996
- JP 4-03, Joint Bulk Petroleum and Water Doctrine, 23 May 2003
- JP 4-04, Joint Doctrine for Civil Engineering Support, 27 September 2000
- JP 4-05, Joint Doctrine for Mobilization Planning, 22 June 1995
- JP 4-05.1, Joint Tactics, Techniques, and Procedures for Manpower Mobilization and Demobilization Operations: Reserve Component (RC) Callup, 11 November 1998
- JP 4-06, JTTP for Mortuary Affairs in Joint Operations, 28 August 1996
- JP 4-07, JTTP for Common-User Logistics During Joint Operations, 11 June 2001
- JP 4-08, Joint Doctrine for Logistic Support of Multinational Operations, 25 September 2002

This is the list of joint logistics publications we reviewed.

The three highlighted at the top (*) are being consolidated and updated.
The two hightlighted in the center (**) are being combined and updated.

Joint Theater-level Logistics Command Authority

The Problem

- While the Joint Force Commander is responsible for theater-level logistics, no subordinate commander is charged with executing that mission

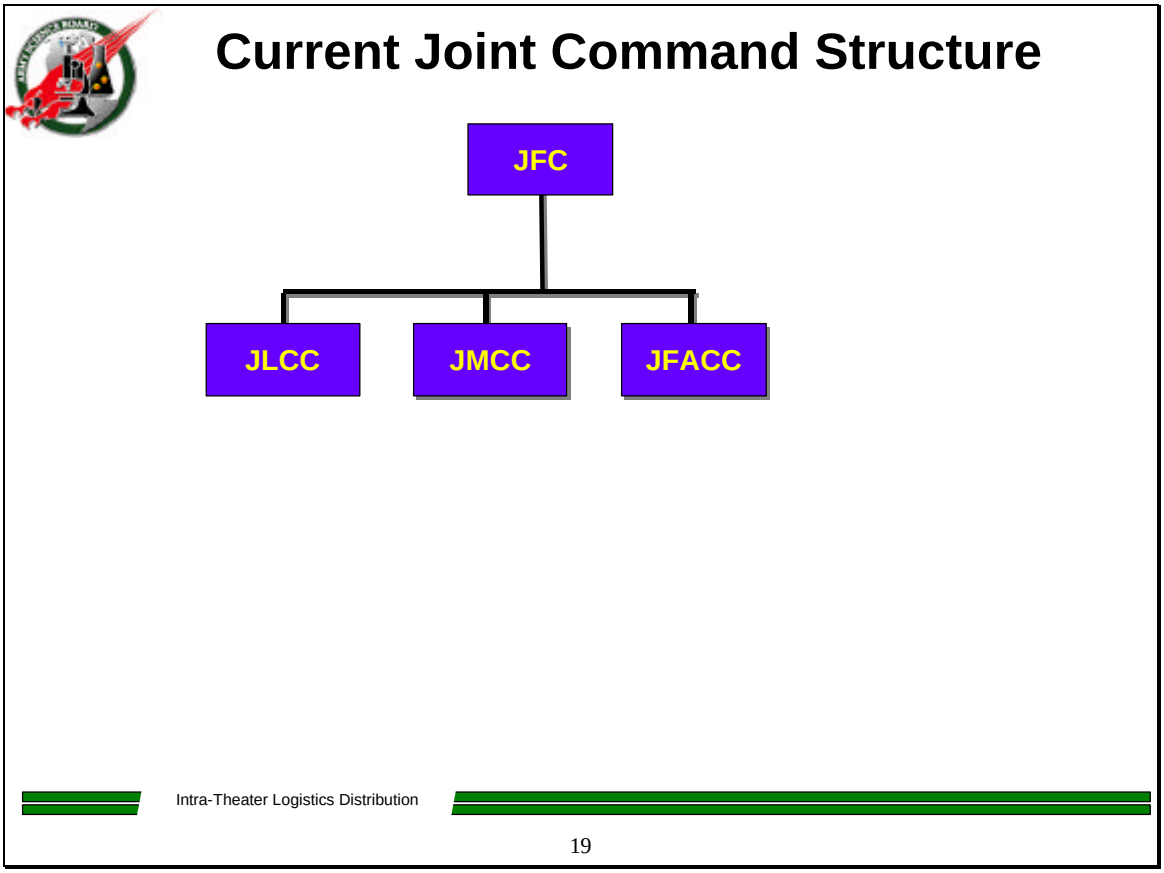
Findings

- Joint Commanders must exercise control over joint logistics resources
- No doctrinal requirement for a theater-level logistics commander

Recommendation

- Establish the doctrinal requirement to provide a joint theater-level logistics commander to a theater-level commander when an operational mission is assigned (TRADOC with G-3)

Joint publication 4.0 April 2000 states “CoCOM includes directive authority for logistics”.

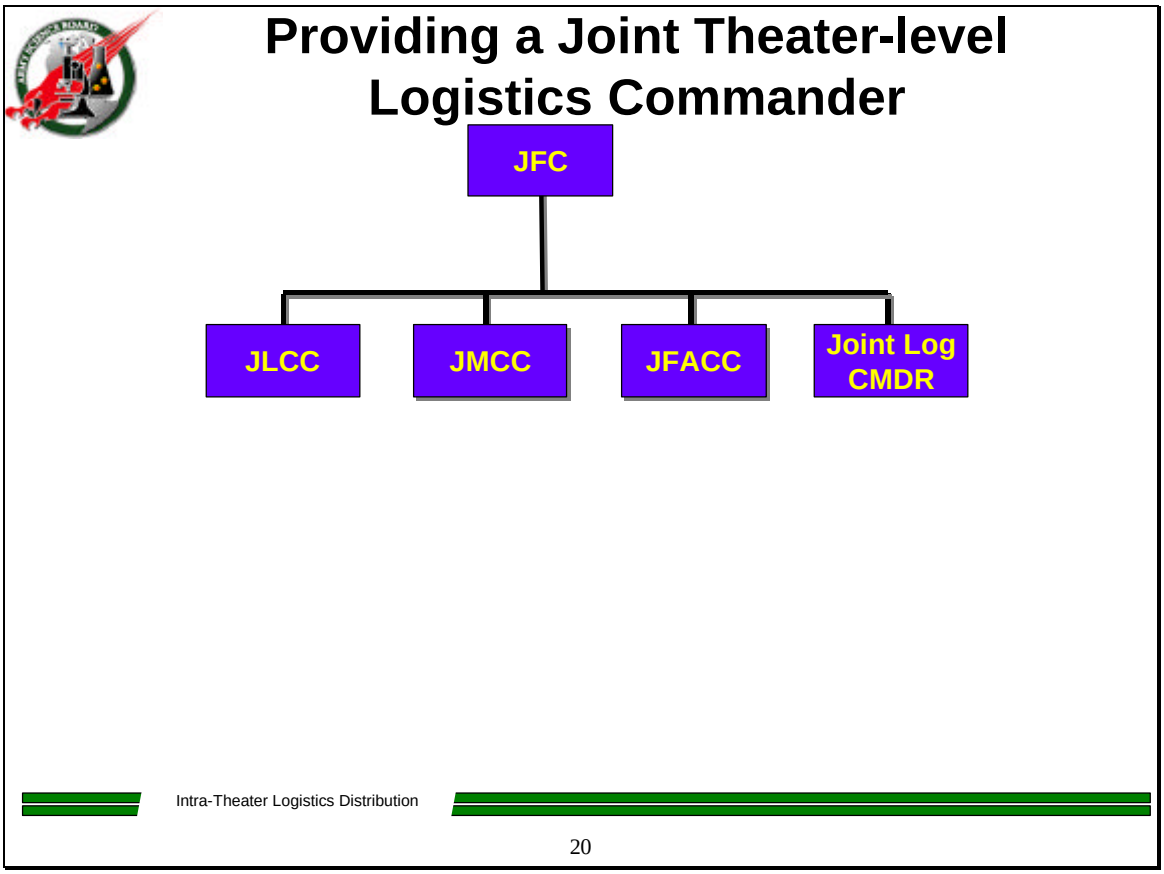


This slide shows the current organization of a Joint Commander with his subordinate component commands.

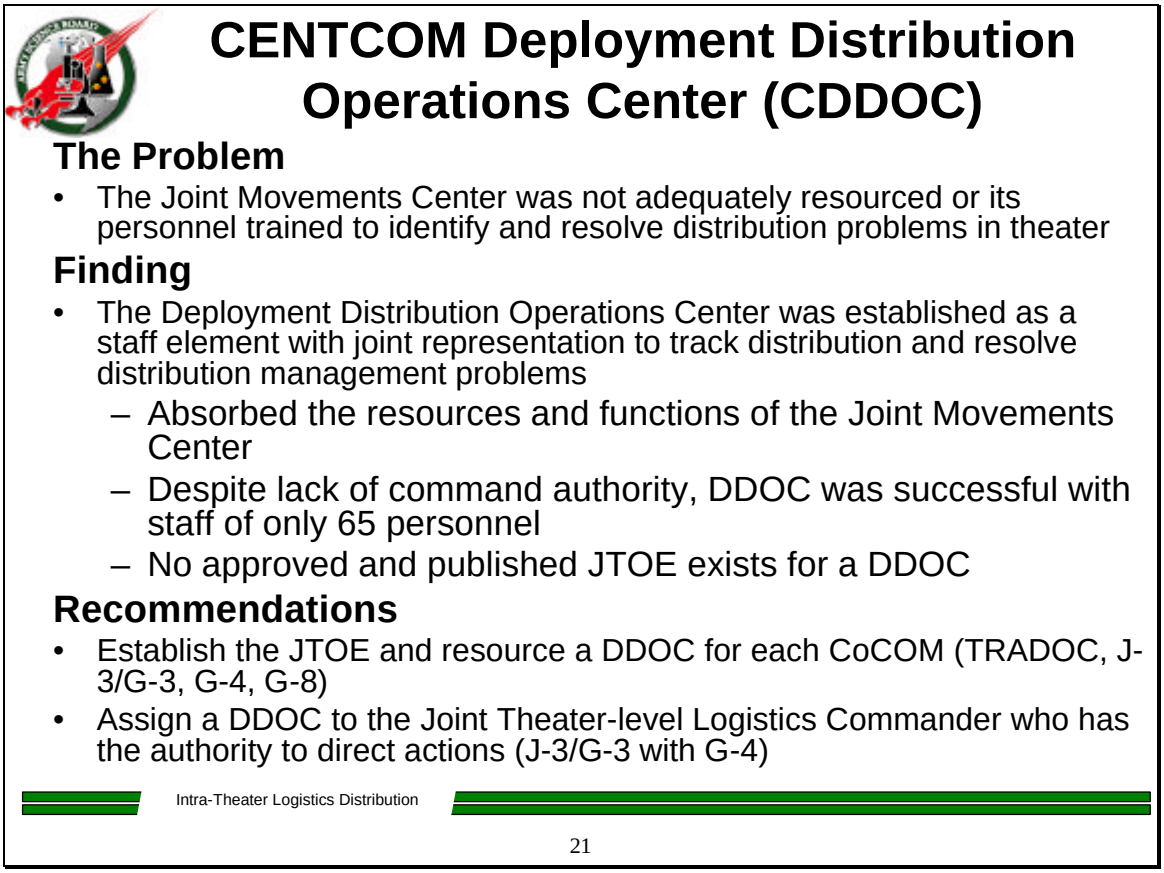
JLCC – Joint Land Component Command

JMCC – Joint Maritime Component Command

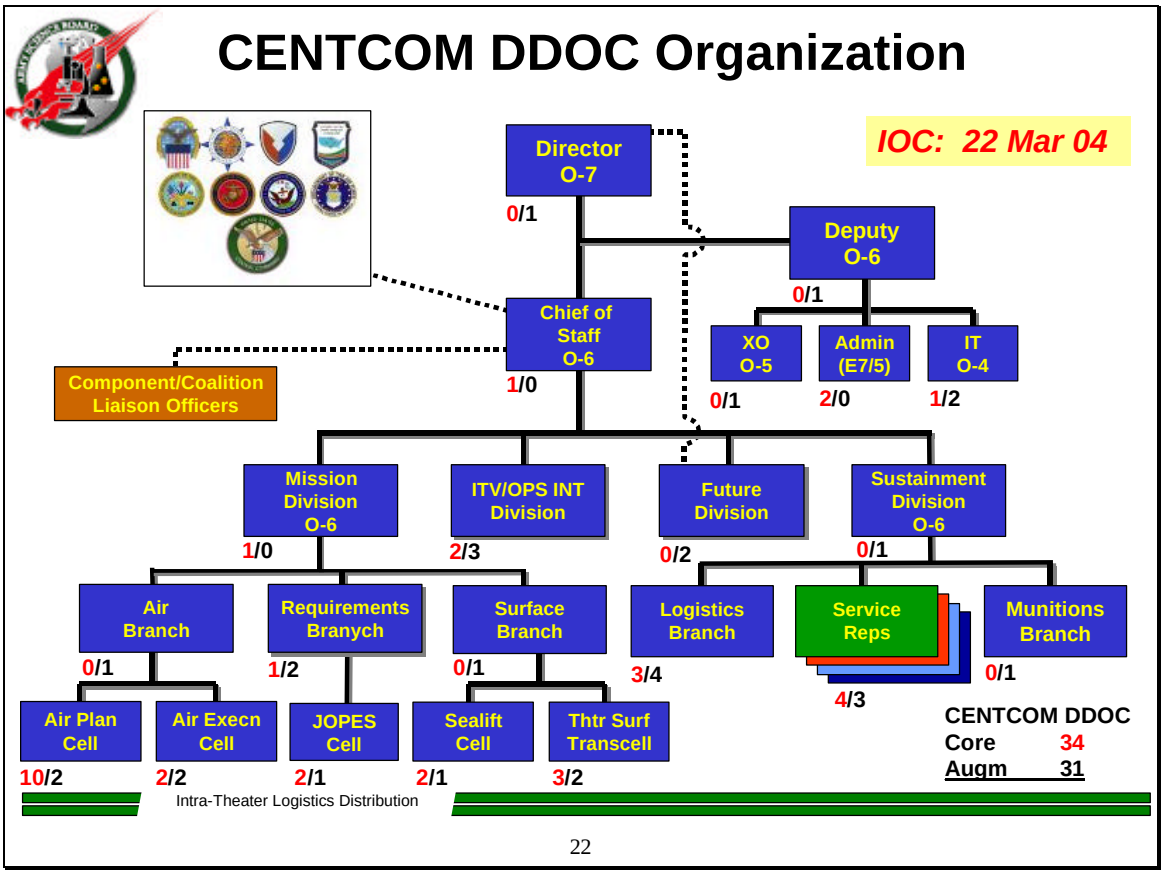
JFACC – Joint Force Air Component Command



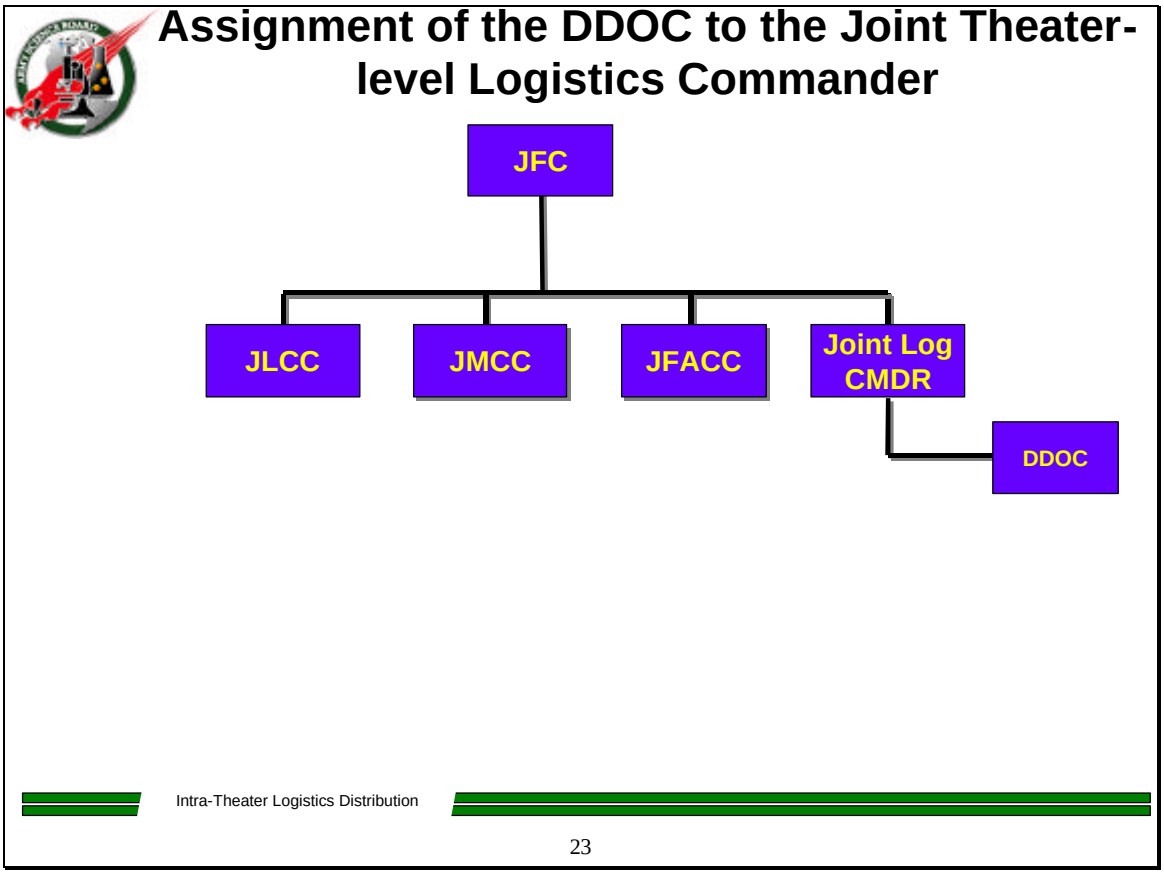
Our recommendation is to provide the Joint Force Commander a subordinate commander responsible for joint theater-level logistics.



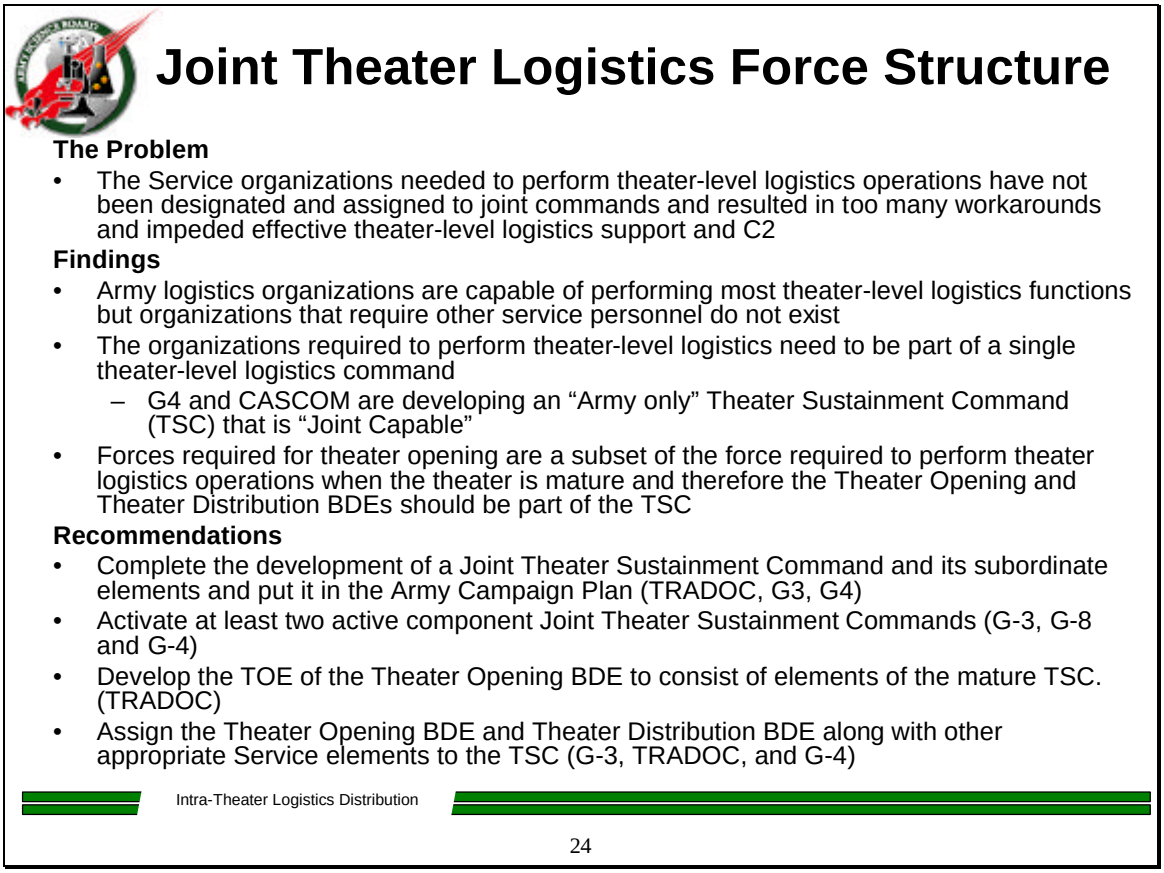
Prior to 22 March 2004 the Joint Movements Center (JMC) performed the majority of the functions now being done by the CDDOC. The Joint Movements Center lacked the personnel, training, and equipment necessary to perform these functions. What the CDDOC brought to the theater was an organization that was adequately resourced with personnel and IT. These personnel were also trained in all aspects of Deployment & Distribution Management. One senior army officer said that the "CDDOC was JMC with steroids." The JMC became part of the CDDOC. However, the CDDOC is an ad hoc organization made up from personnel from the Services and DoD agencies. A JTOE should be developed and at least two stood up in the active component.



This chart shows the actual composition of the CDDOC organization. The CDDOC was organized on 22 March 04 and integrated the JMC into the CDDOC at the request of the CENTCOM J-4 as a test. This organization has been very effective but currently is simply a staff organization.

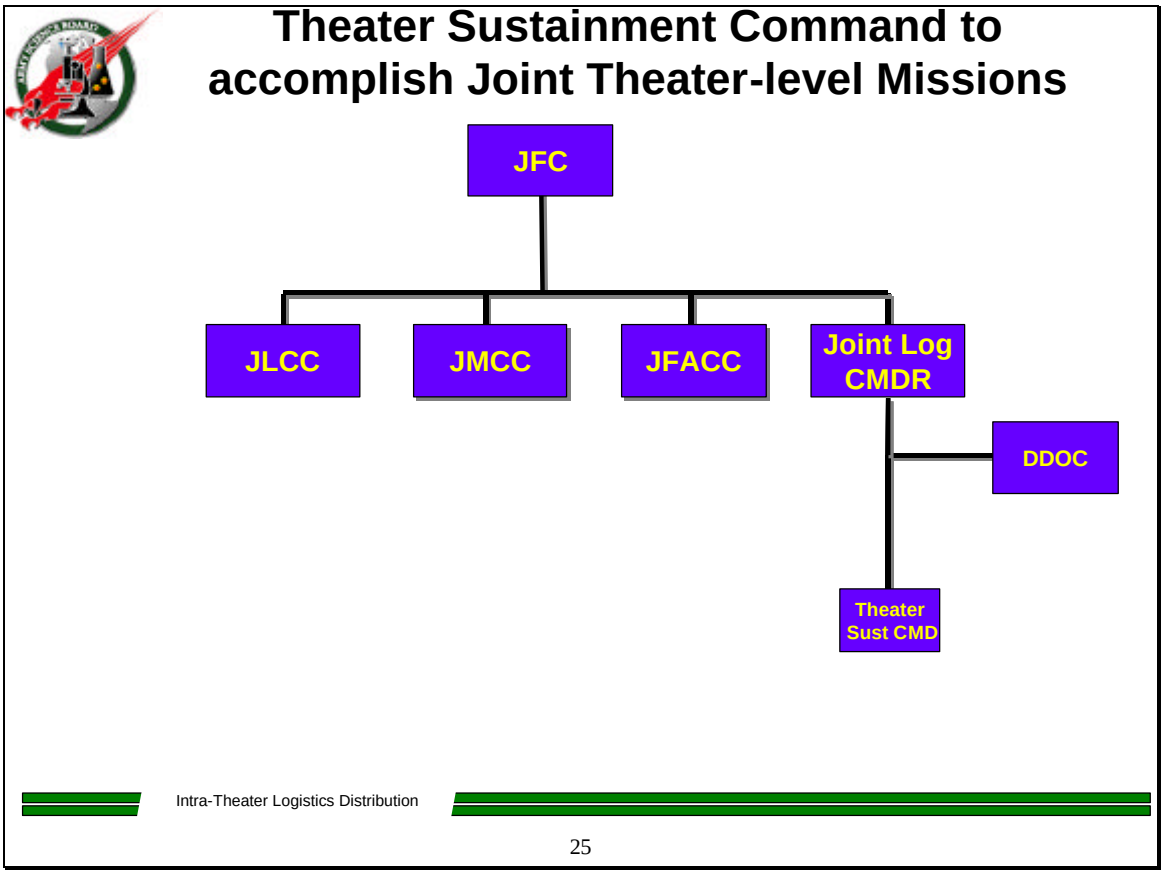


This slide simply shows the assignment of the DDOC to the Joint Theater-level Logistics Commander. It is not clear whether the DDOC provides the complete staff capability for the Joint Theater-level Logistics Commander or whether it is a subset of the Joint Theater-level Logistics Commander's staff.

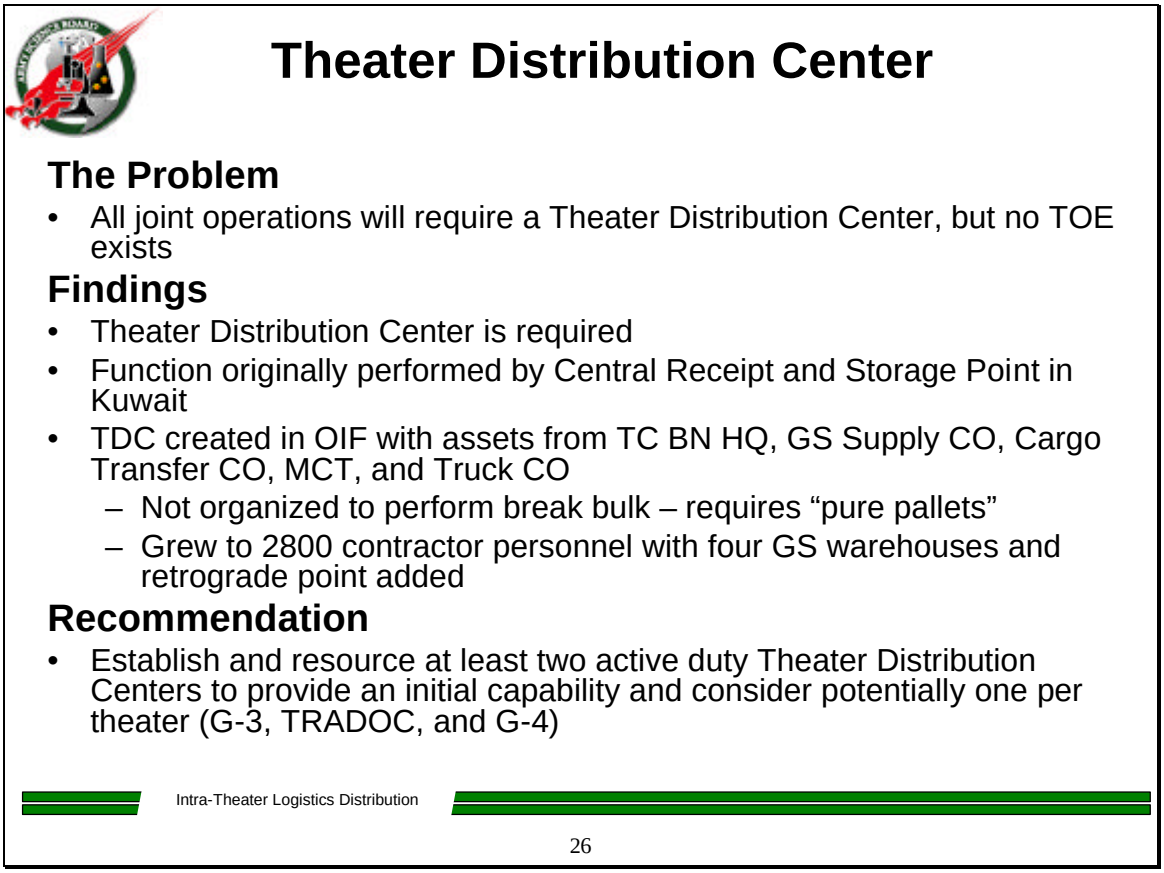


Theater opening and Sustainment are a joint responsibility. Currently, due to the Army support to other Services responsibilities, the Army has taken the lead with respect to Theater Opening and Sustainment. During OIF the CENTCOM Cdr designated the CFLCC C4 as the "one belly button" responsible for sustainment and distribution because of the capabilities/contributions of other services and DoD agencies. This is an "after the fact" decision. A commander for Theater Sustainment/Distribution must participate in all planning for the operation. There were several hand-offs for sustainment/distribution before and during OIF. We believe that the Theater Sustainment Command (TSC) would consist of the Theater Opening and Distribution BDEs plus other DoD agencies and other Service Sustainment/Distribution capabilities. The TSC should include the assignment of Army Theater-level finance, engineer, personnel, and medical C2 units.

In reviewing the CASCOM TF Logistics Concept, it is not clear what happens to the Theater Opening BDE as the theater matures. Forces required for theater opening are a subset of the force required to perform theater logistics operations when the theater is mature and therefore the Theater Opening and Theater Distribution BDEs should be part of the TSC. Develop the TOE of the Theater Opening BDE to consist of elements of the mature TSC. The relationship of the port operation capabilities of SDDC to the Theater Opening BDE needs to be established. We recognize that this is a "fast moving train" and want to make sure this issue is addressed.

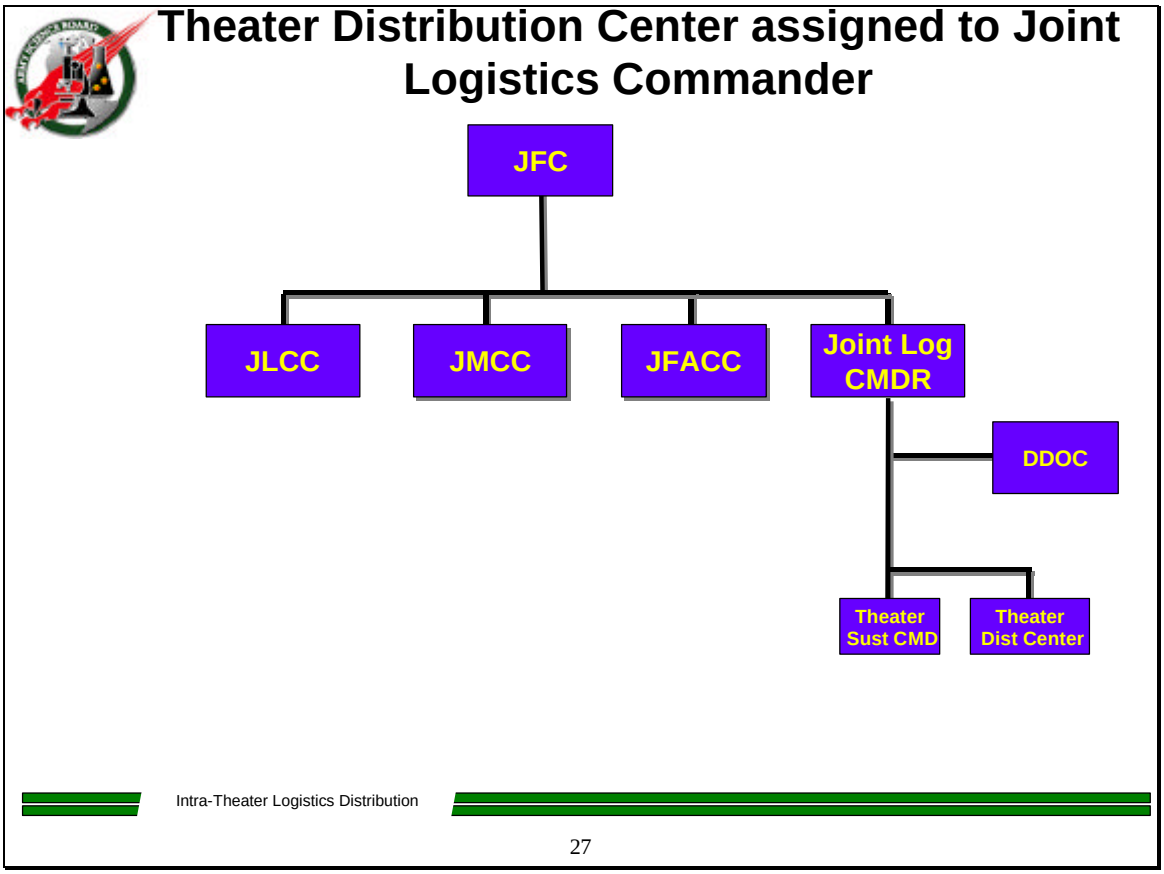


This slide now shows the assignment of a command responsible for theater-level sustainment. The theater opening BDE would be a part of this command.

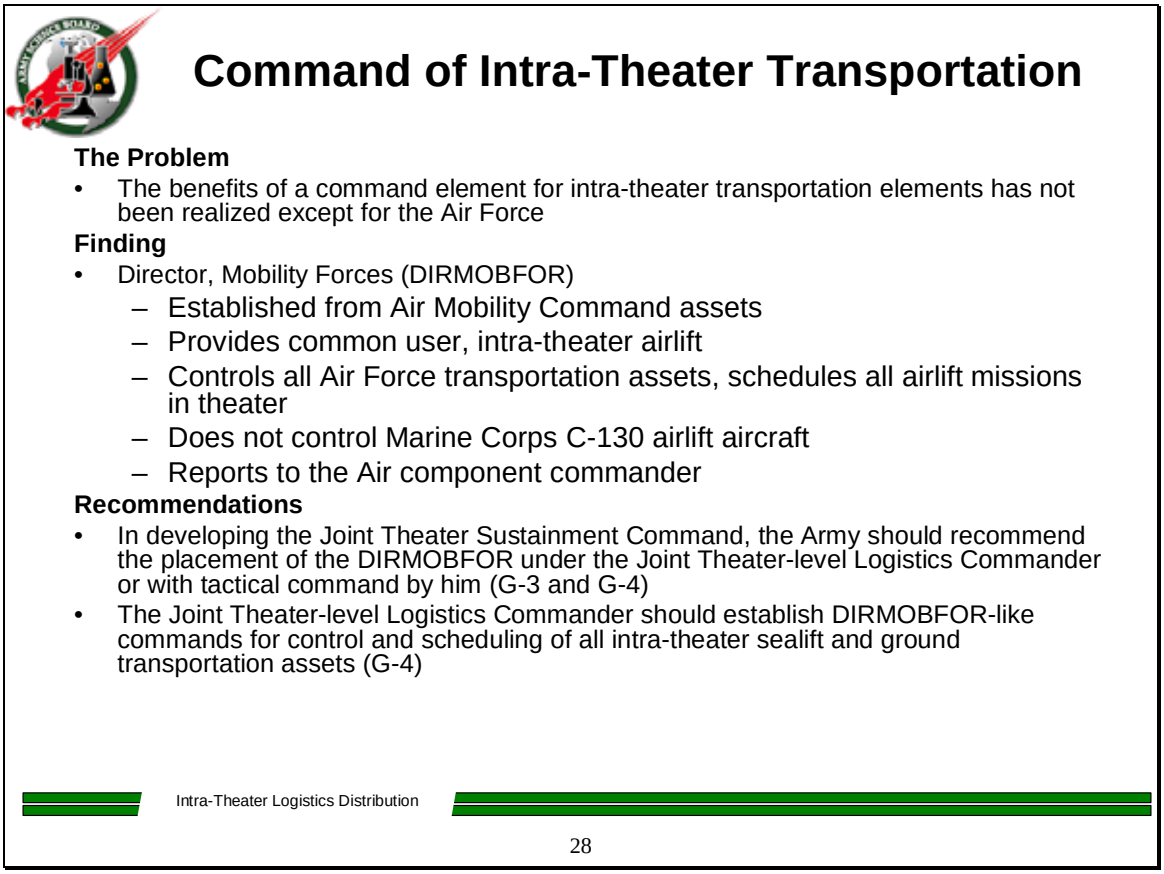


Receipt, Staging, and Onward movement will not work without a TDC. They have to be created each time we deploy and they are created differently by different Joint Commands. TDCs are needed in the active force so they can participate in all aspects of planning with the Joint Commands. The HQ of a TDC needs to be in the active component. A joint TOE must be developed and resourced and the down trace of the subordinate elements for each TDC needs to be identified. Although Army units were used to create the TDC in OIF, a more capable TDC might have been established if some other service and DoD agency activities were part of the initial TDC.

Using LOGCAP task orders, the TDC and associated functions grew to 2800 contractor personnel running four GS warehouses and a retrograde point. The phasing of LOGCAP into the TDC should be determined by the Theater Sustainment Command Commander.



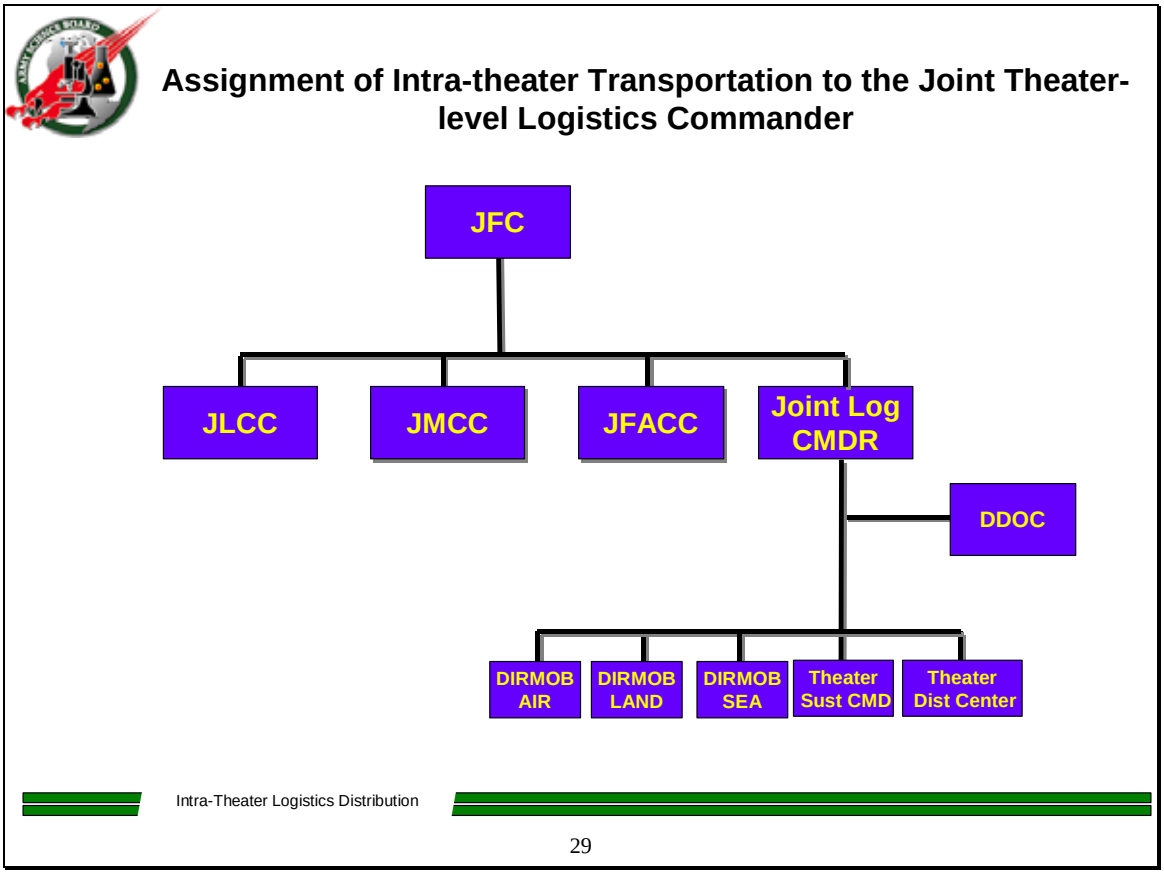
This slide shows the TDC as an essential element reporting to the Joint Theater-level Logistics Commander. The TDC could just as easily be under the Theater Sustainment Command.



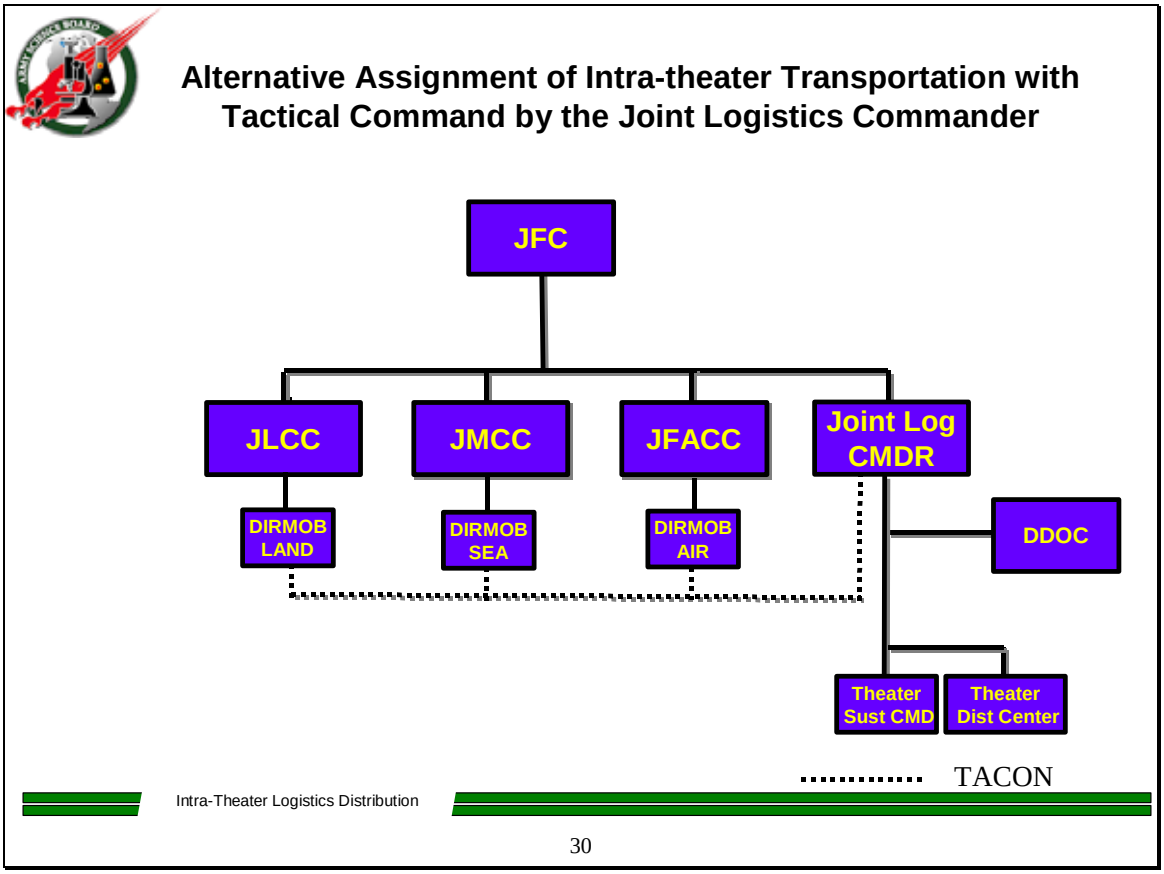
Command and control of airlift assets that are deployed to support operations in a theater is exercised by an Air Mobility Command element in theater that is titled the Director, Mobility Forces and subordinated to the Air Force Component Commander in theater.

This commander would be better positioned under the Theater Joint Logistics Commander or, at least, placed under the tactical command of the Joint Theater-level Logistics Commander.

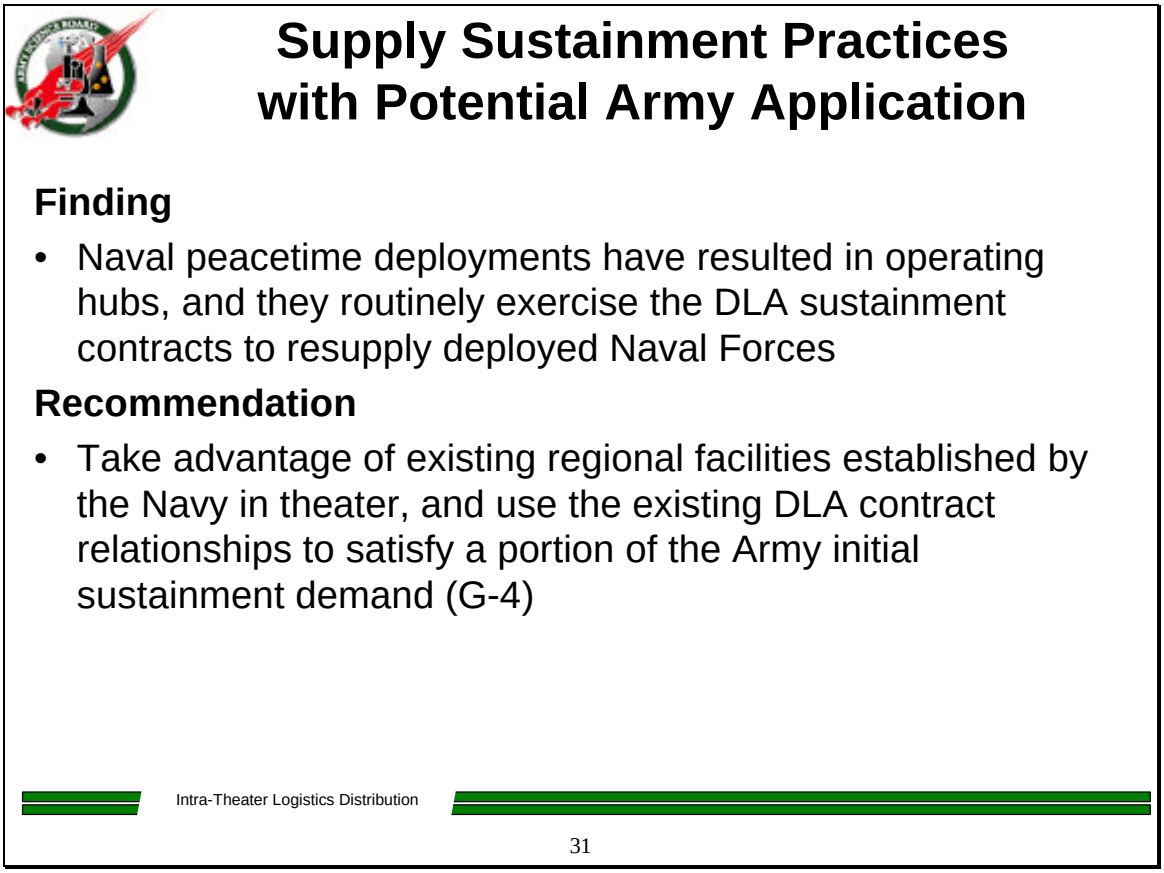
This command and control concept should also be established for the control, scheduling and prioritization of intra-theater sealift assets as well as the intra-theater ground transportation assets to achieve the benefits that have been realized by the Air Force.



This slide shows the placement of air, land, and sea intra-theater transportation commands under the Joint Theater Logistics Commander.



This slide shows an alternative configuration.



Supply Sustainment - Naval traditional deployment patterns have resulted in the establishment of operating hubs in each theater which provide for routine resupply of deployed Naval Forces.

Expeditionary nature of Naval Forces has resulted in the development of consumption rates for all classes of supply for a range of Naval formations and operating tempos.

Naval Forces use existing DLA worldwide contracting arrangements to satisfy sustainment demand as close to the theater as possible.

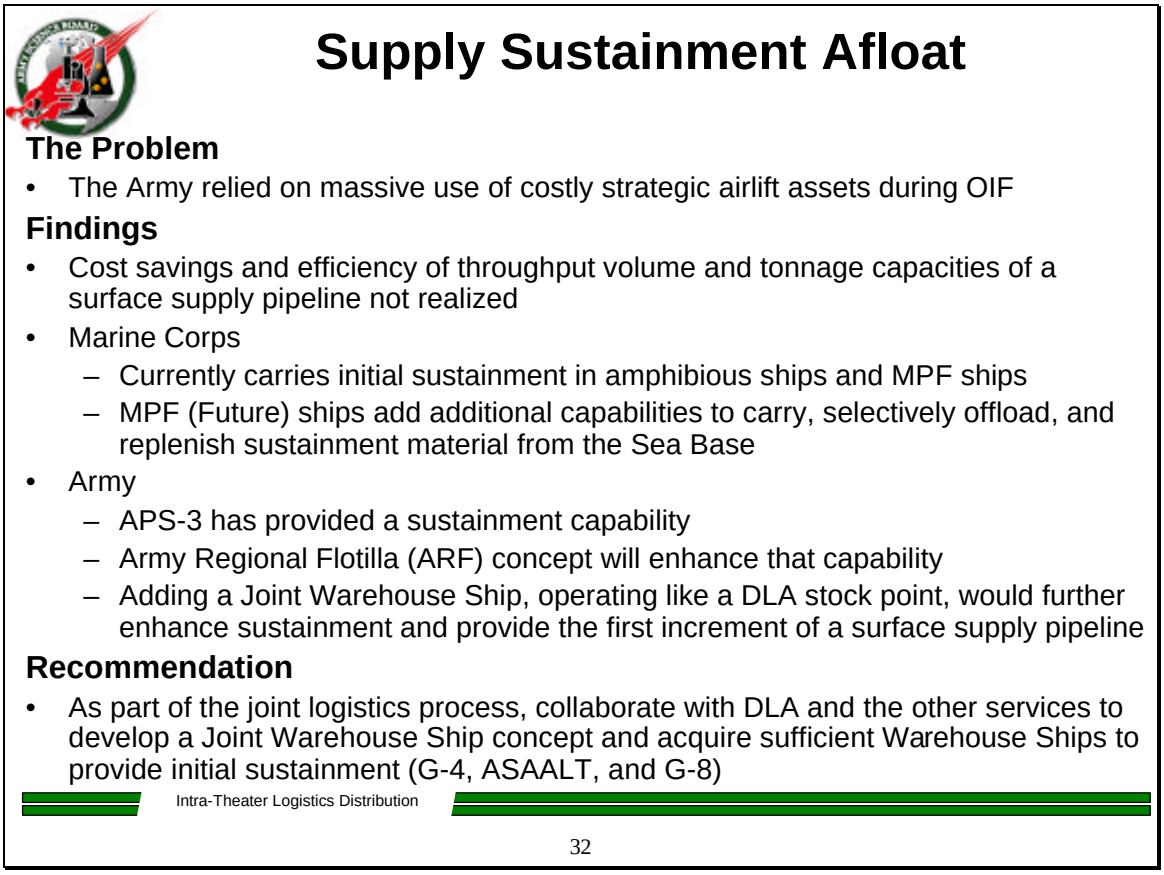
Anticipated demand and tailored load lists aboard MSC-operated Combat Logistics Force ships allows stock positioning and economic pipeline fill to support deployments.

Non-traditional Naval deployments to immature theaters such as Somalia or East Timor have required new DLA contracting with vendors and the establishment of APODs in Kenya or Australia, but traditional consumption rates were still germane.

A Regional Hub Example - The Jebel Ali port facility is the largest container port in the Middle East and serves as a warehousing and distribution hub for a market of roughly two billion people. The Ports, Customs & Free Zone Corporation handled 5.15 million twenty-foot equivalent units (TEU) in 2003.

The Navy and Marine Corps routinely pass containerized cargo through the Jebel Ali port facility while deployed in the Persian Gulf region.

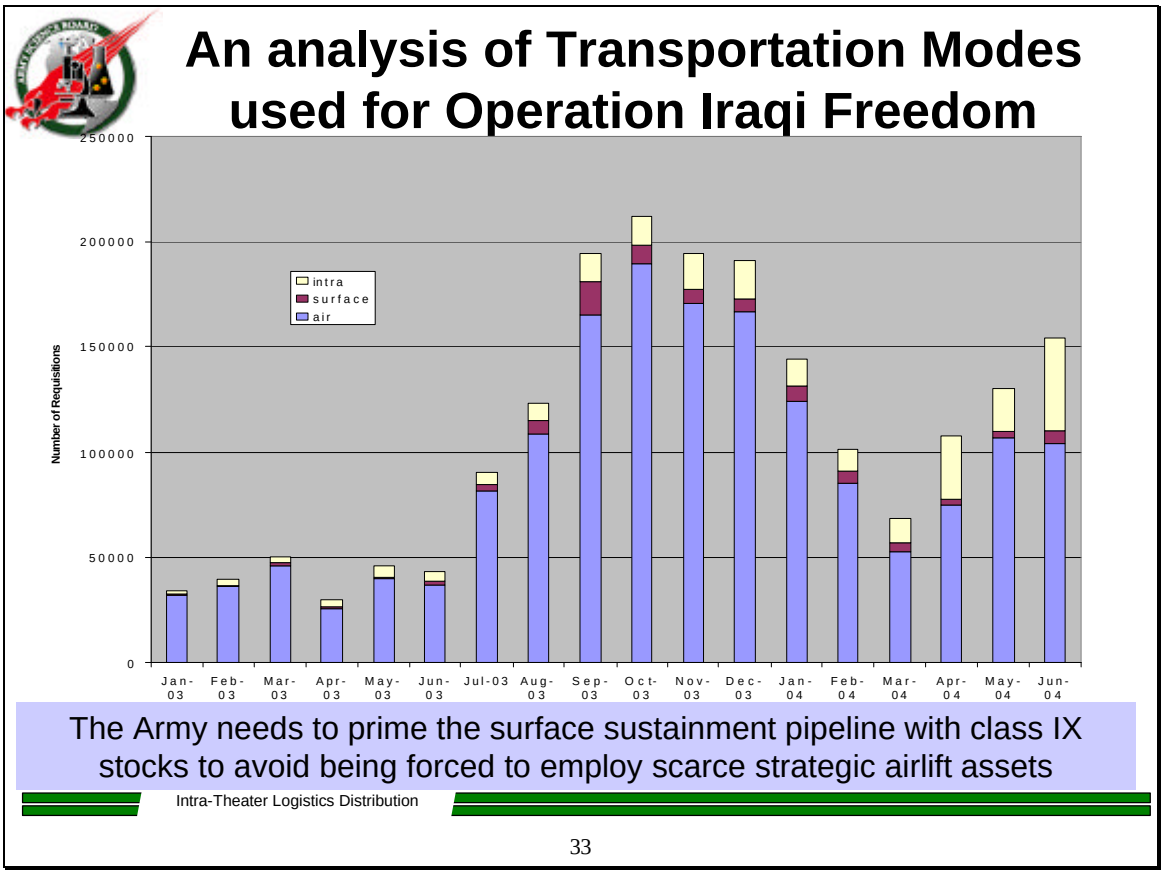
Take advantage of existing regional facilities established by the Navy in theater, and use the existing DLA contract relationships to satisfy a portion of the Army initial sustainment demand.



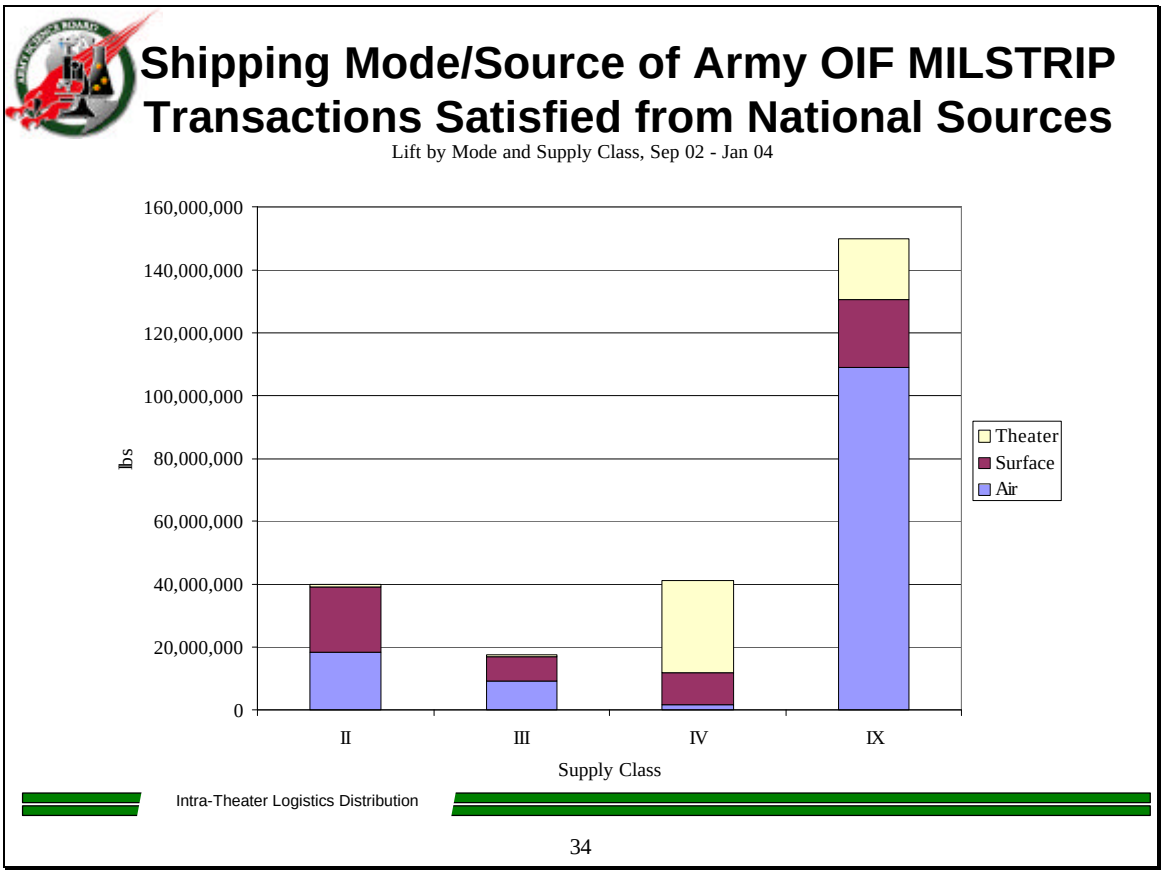
Priming the Sustainment Pump - Prepositioned Material afloat is a proven concept and the Army Regional Flotilla concept will move APS-3 forward. Addition of a Joint Warehouse Ship concept will further enhance APS-3/ARF and gain synergy as part of Joint Seabasing.

Supply afloat provides the first increment of a surface supply pipeline that must be established from the outset of deployment to a theater in the most responsively economic manner possible.

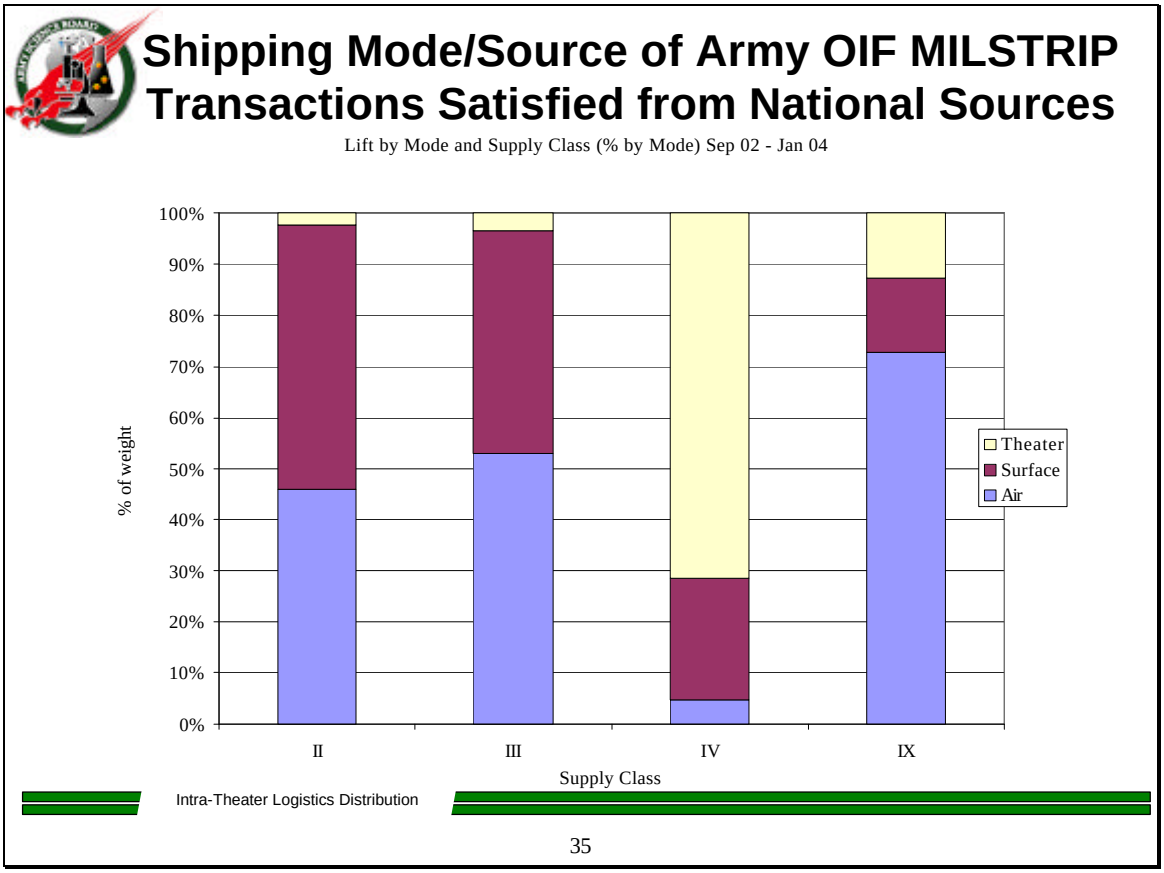
The Army should collaborate with DLA and the other services to develop a Joint Warehouse Ship concept and acquire sufficient Warehouse Ships to provide initial sustainment.



As indicated in the previous problem statement, the Army has depended upon airlift for the majority of its sustainment needs. This chart provides a look at the mix of airlifted requisition fulfillment versus those requisitions filled using surface shipping during the past 18 months, and reveals that more than 80 percent of the material is being airlifted as compared with historical shipping mode norms in which 80 percent of material is normally shipped by sealift.



This chart looks at tonnage shipped by air and surface modes by class of supply



This chart reflects the same data as the previous chart but has converted actual weight into percentages.

Logistics Practices of Other Services
Supply Sustainment Afloat

The Problem

- The Marine Corps currently carries initial sustainment in deployed Amphibious ships as well as in the current MPF ships. There are plans to include additional capabilities to selectively offload and to replenish sustainment material as part of the top level requirement for the MPF (Future) ships

Finding

- Army Prepositioned Material afloat, APS-3, has provided some sustainment capability and the Army Regional Flotilla concept will move that capability to the next level. The addition of an Army Warehouse Ship to the ARF would further enhance sustainment and could gain synergy as part of Joint Seabasing

Recommendations

- The Army should take full advantage of the throughput volume and tonnage capacities of a surface supply pipeline but should develop the means to deal with initial sustainment needs until the surface pipeline can be established.
- Acquire Army Warehouse Ship(s) to provide the first increment of a surface supply pipeline
- Join the USMC and Navy as an active participant in developing Joint CONOPS for Seabasing

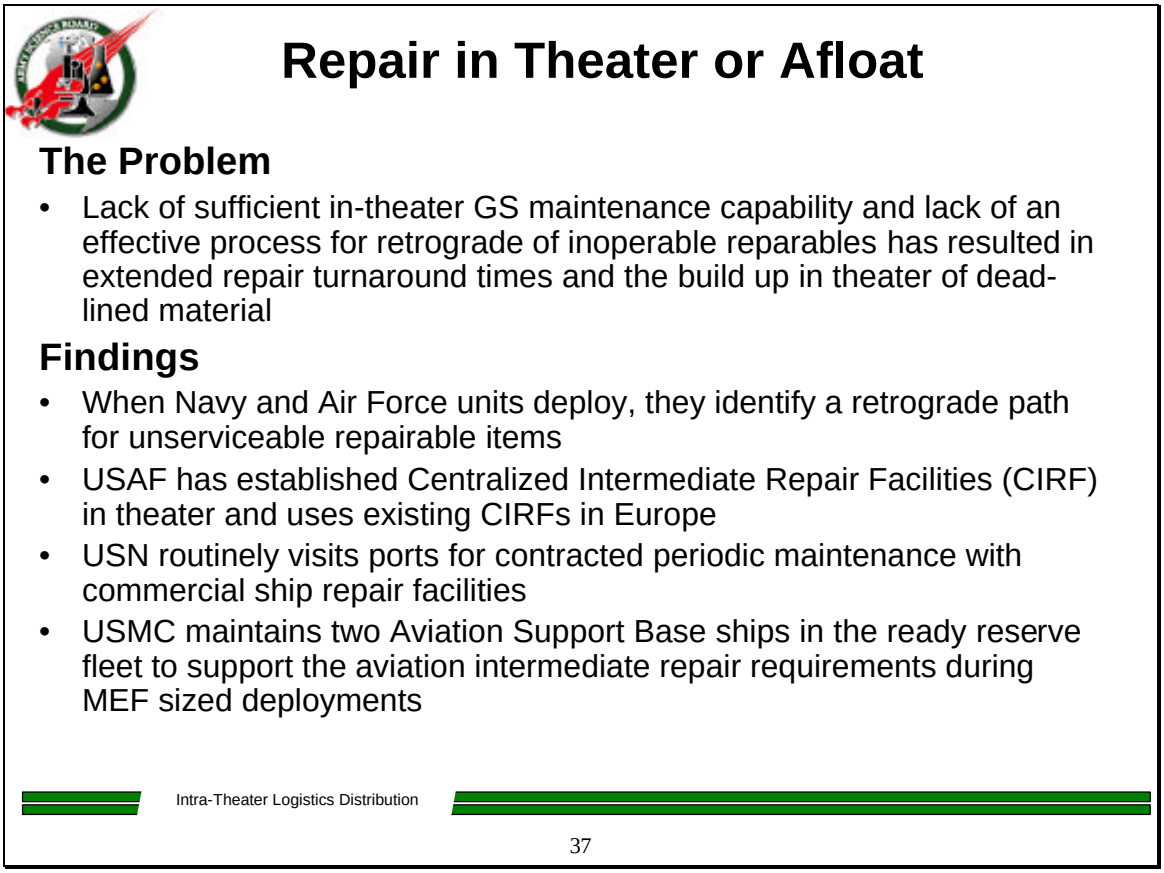
Army Regional Flotilla (ARF) Plan calls for the establishment of three elements, All having 1x1 unit sets plus CS/CSS/sustainment

- ARF Mediterranean, ARF Diego Garcia, ARF Guam/Saipan

Warehouse ship

- Capable of supporting one division with critical supplies for 30 days
- Operate like a back-up theater SSA afloat similar to a DLA stockpoint
  - An SSA afloat would have the mission to support the initial force deployment until a theater distribution center could assume the mission
    - Initial sustainment
    - All classes except bulk fuel and ammunition
    - Sized for high OPTEMPO MTW
- Features
  - Operates in a port or at sea as part of Navy Seabase
  - Automated warehouse with AIT, STAMIS interoperable
  - Break bulk, container, and RORO capable with selective container discharge
  - As technology allows and CONOPS dictates, at-sea receipt/delivery via lighterage, helicopter, commercial ships, Navy AFS (auxiliary food and stores) resupply ships, DLA depot afloat.

- Seabase – bases forces, logistics, and support at sea and offers a reliable, flexible environment from which to operate when secure, fixed bases are not available. Exploits strategic maneuver space inherent in sea based operations.



In order to set the stage for this problem, a discussion and definitions of levels of repair follows:

- Direct support maintenance. For the first thirty days, DS maintenance consists of triage, battle damage assessment and repair, and light component replacement. As the situation stabilizes, DS maintenance would move to replacing power train components, welding and minor fabrication. DS maintenance is very tactical and a centralized facility, either ashore or afloat, is not recommended.

- General support maintenance. The next higher level of maintenance is general support (the old 4th echelon). This involves extensive repairs to cannibalized "hangar queen" end items and repair and overhaul of computers, avionics and engines and other power train components. GS maintenance would lend itself to a centralized facility, again either ashore or afloat.

- Generally, the most efficient and cost-effective approach is to retrograde depot level reparables to CONUS contractors and/or organic repair facilities. Clean and well-organized facilities will produce higher induction quantities, higher quality repair, and longer MTBF of repaired assets. Key LRUs can be assembled in production line quantities. Applicable modifications can be installed and repaired items can be returned to stock.
  - The primary advantages of in-theater GS repair are quicker turn-around of repaired assets, return of assets to units vs. to stock, flexibility of repair schedules and avoiding the impact of Department of Agriculture standards for the importing of equipment.

- The disadvantages of repair in-theater are production inefficiencies, work stoppages for lack of LRUs, quality of repair and resultant shorter MTBF on repaired items, and the cost (both in dollars and footprint) of the repair infrastructure.
- The decision to repair in theater also depends on the theater. In Iraq, for example, a GS repair facility could be set up in Kuwait, other locations in theater, or afloat.

- The Air Force established two level maintenance in theater

  - Forward Operating Locations (FOL) for on equipment maintenance/phase inspections with minimal back shop capability and supported with Mission Ready Spares Packages (MRSP) with reach back to Europe and CONUS

  - Centralized Intermediate Repair facilities (CIRF) for off aircraft repair of ECM & LANTIRN pods at locations in theater

  - Plus they used reach back to existing CIRFs in Europe for Engines (F-15, F-16, C-130), F-15 avionics, wheel and tire (C-130 & KC-135), and KC-135/C-130 fuel cell repair.

  - Establishing CIRFs in theater for repair of aircraft components that are essential to combat sortie generation was necessary for the Air Force to sustain the required high optempo.

  - Reach back to existing CIRFs in Europe for repair of other aviation components was possible because the available assets in the pipeline was sufficient to support required sorties with the additional repair turn around time associated with the additional transportation.

- Rota, Naples and Pireus for the Med, Yokosuka, Sasebo and Singapore for the Pacific, Bahrain and Jabel Ali for the Persian Gulf; are some of the locations that routinely are used for repair.

- The USMC has a floating repair capability for aviation intermediate maintenance. In the mid 1980s the Navy bought two RORO cargo container ships, the Wright and the Curtiss. These ships were heavily modified for aviation support. Each ship can carry up to 300 20-foot ISO containers, which have been specially fitted to house USMC aviation maintenance capability. In CONUS, the USMC performs aviation intermediate maintenance in these same containers. The Marines activate one of the Aviation Support Base ships each year to participate in a major exercise and deploy the Maintenance vans and the associated Marine repair crews.

- USN and USAF establish and depend upon GS maintenance capabilities in-theater as reflected on this chart.

Repair in Theater or Afloat (Cont)

Findings (Cont)

- The Army has established AMC forward repair activities, but with limited component repair capabilities
- GS repair afloat considerations
  - Establishing Army GS repair afloat gains synergy, especially in terms of force protection, when operating as part of Navy Joint Seabasing concept
  - Repair procedures should be limited to components because neither space nor transportation would be available to bring end items aboard

Recommendations

- The Army should implement a retrograde policy for reparables similar to that in place with the Navy and the Air Force to avoid build up in theater of items requiring depot level repair (G-4)
- Establish a GS repair capability in theater...not as part of the theater opening package but as a sustaining element (AMC/G-4)
- Evaluate existing USN/USAF repair facilities in theater and assess the potential to accommodate Army repair requirements in them (AMC/G-4)
- Participate actively with Navy in developing Joint Seabasing CONOPS (G-4)
- Do a cost/benefit analysis of providing GS repair capability afloat (G-4)

The Army needs a similar GS maintenance capability. The repair of ground equipment is different enough from aviation repair that a decision would have to be made as to desired capability. Tools and equipment would have to be adapted to ISO containers. This is much more complicated than just stationing a conventional GS maintenance unit on a ship.

- Making some arrangement to use the Wright or the Curtiss could be explored; however, it is unlikely that the USMC would see advantages to making extensive modifications.
- Cost would be a consideration. Aside from the initial procurement and modification costs, the Wright and the Curtiss are maintained in a reduced operating status when not activated. A civilian commercial US Merchant Marine crew is stationed aboard each ship to monitor equipment conditions and conduct vehicle maintenance and repair.
- Of course, if GS maintenance is desired in theater, then the infrastructure for afloat capability needs to be compared to the infrastructure for that ashore. In effect, the afloat facilities trade transport of reparable assets from shore to ship and back for reduced footprint of fixed facilities on the ground.
- Consider equipping an available ship in the Ready Reserve Fleet with existing vehicle repair tools and supporting equipment for employment in the Iraqi theater, similar to the Marine Corps Aviation Support Bases afloat.
- Considering the above, it is obvious that a cost benefit analysis should be conducted.

In-transit Visibility Practices of Other Services

Findings - Cargo Movement Operations System (CMOS)

- **Air Force:** Developed transportation movement information system to be used in both peace and war, with links to Global Transportation Network.
  - Fielded at 200+ shipping sites. Deployable version exists
  - Provides initial training and help desk support
  - Ongoing dialogue with CENTCOM staff concerning CMOS for Theater Distribution Center and Corps Distribution Center in Iraq
- **Marine Corps:** Fielded at 14 active duty sites (CONUS and overseas); testing software for implementing at all Reserve sites
- **Navy:** Fielded at 6 overseas locations and Naval Air Station Norfolk
- **Army:** Successfully using CMOS as the European Theater Distribution Center system of record and 21st Theater Support Command is evaluating use at other sites

Recommendation

- Take advantage of an investment already made by the Air Force in Cargo Movement Operations System (CMOS) rather than developing a separate Army transportation movement information system, expedite completion of current assessment of CMOS, and direct PM-TCAIMS-II to develop an implementation plan to field CMOS Army-wide (G-4, PM-TCAIMS-II, G-8)

Cargo Movement Operations System

Designed to help logisticians manage their assets by providing visibility over materiel in the transportation pipeline while providing decision-makers with information to monitor the dynamic arena of capability versus requirement in the mobilization, deployment, sustainment, and redeployment of forces.

Standardize operations in the areas of data collection and shipment accountability in addition to shipment processing, manifesting, and reporting while increasing productivity by connecting with defense logistics systems through standard communication protocols and with commercial trading partners through electronic data interchange (EDI) software

Promotes efficiency by capturing data once, using automated information technology (AIT), cutting transactions and record keeping and analyzing performance to pinpoint problems.

Army: European TDC system of record; 21st Theater Support Command (TSC) evaluating use at other USAREUR shipping (ASAMMCE, outbound SSAs) and receiving (inbound SSAs) activities

CENTCOM: Ongoing dialogue with CENTCOM staff concerning CMOS for TDC and CDC

USMC: Currently 14 active duty sites (CONUS and overseas); testing software for implementing at all Reserve sites

USN: Currently 6 overseas locations and Naval Air Station Norfolk

DCMA: Ongoing dialogue with DCMAO Israel concerning use of CMOS for shipping

Air Force: 200+ active duty, Guard and Reserve shipping sites

Deployable version available for sites without adequate bandwidth

USAF provides initial training support, 24/7 help desk support; users participate in requirements identification/prioritization process

Army/Land Component Logistics Force Structure

The Problem

- The Army component assumed, and received, the responsibility for most of both the theater and land component opening and sustaining force requirements. As a result, the Army/LCC assumes tasks that are joint in nature but that have no effective joint logistics command and control

Findings

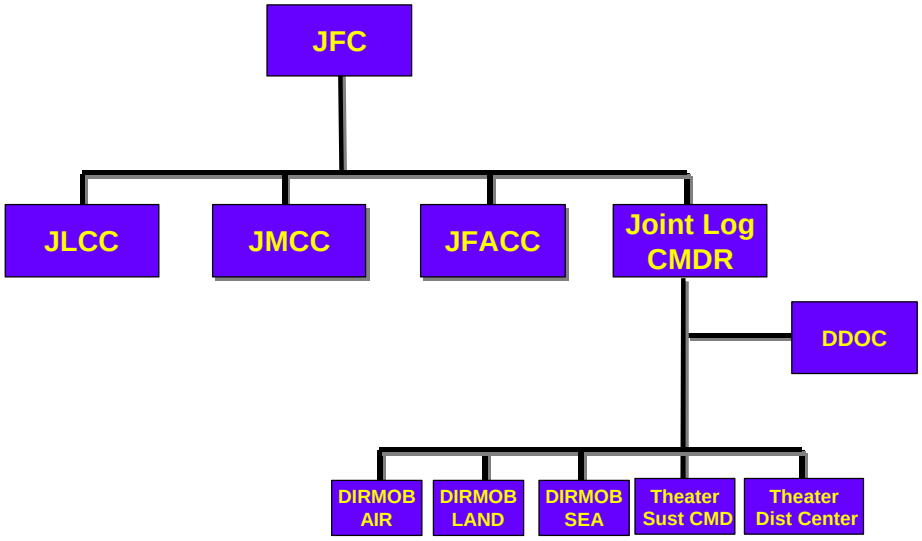
- Once the designation of units performing joint functions has been made, no new Army force structure is required to perform logistics functions for the Army component commander
- The Army component opening capability should be a subset of existing logistics organizations. The land component opening packages need to be developed and deployed concurrently with the joint theater opening package

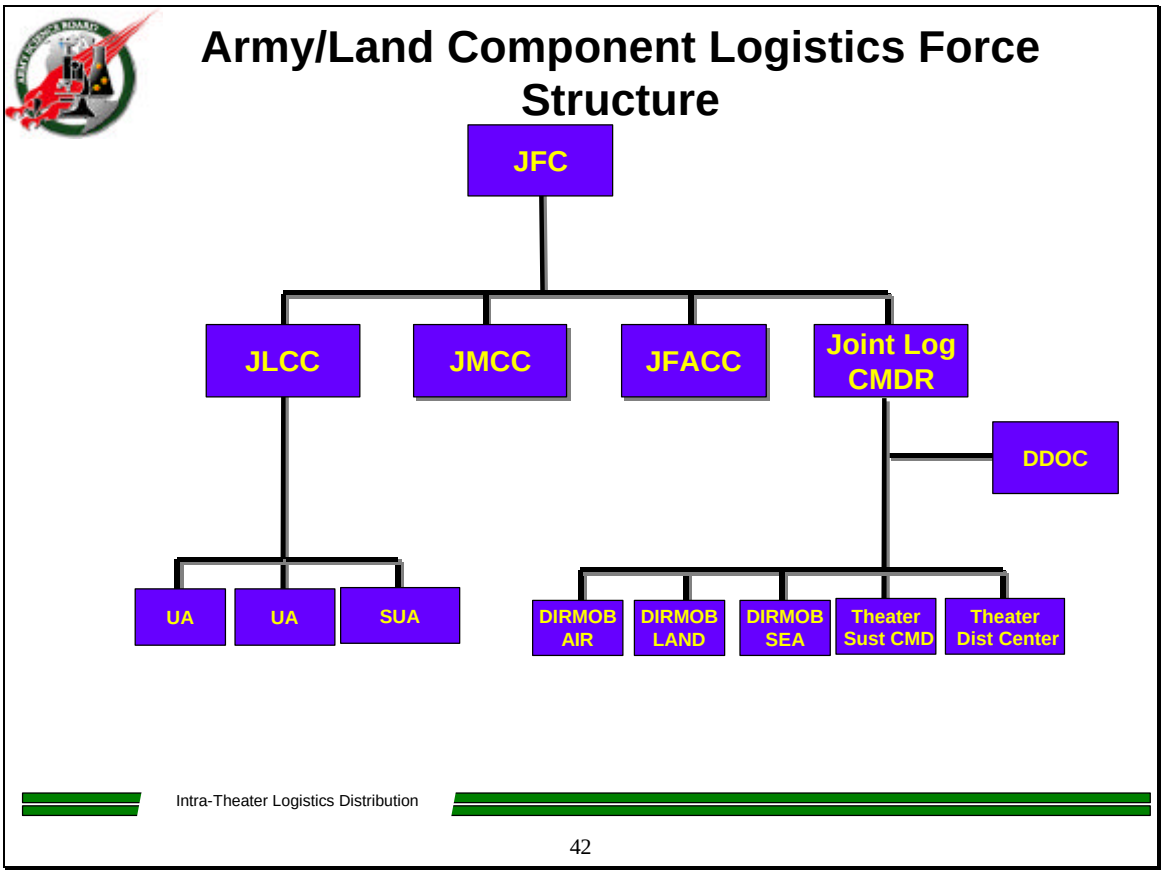
Recommendation

- Designate the portion of the Army Component Command/Land Component Command logistics structure that needs to deploy with the Joint Force opening forces to interface with it and commence early operations (TRADOC with G-4/G-3)

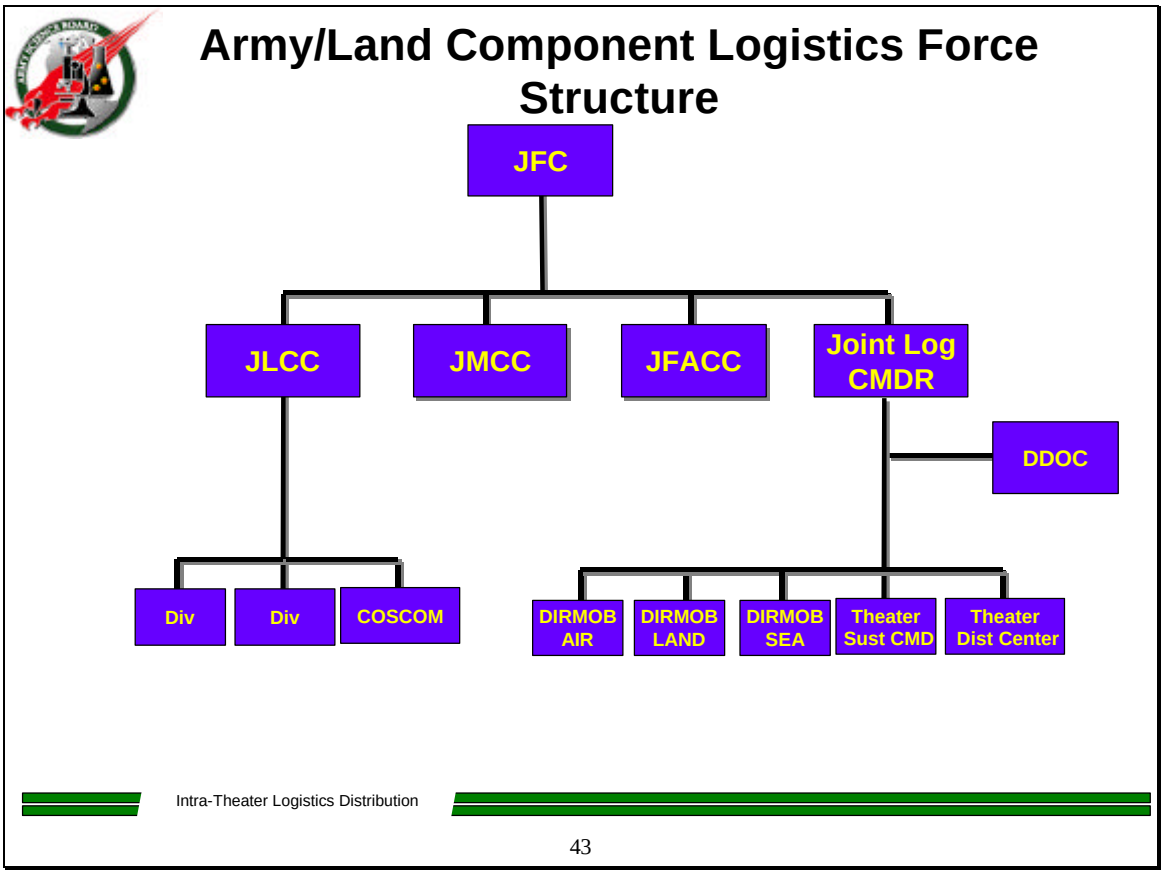
The LCC also needs a logistics capability with appropriate C2. The Army has designed specific logistics force structure to align with combat forces. While additional force design work may be appropriate to accommodate new modular BDEs, it does not appear that additional logistics force structure is required. In fact, once the appropriate structure is provided to the Joint Force Commander, the command and control of Army/LCC logistics units will become even easier.

Army/Land Component Logistics Force Structure





As an example, if the LCC combat force requirement were satisfied with two Units of Action, then the appropriate logistics structure might be satisfied with a Sustainment Unit of Action.



If however, the combat requirement were satisfied with two divisions, the logistics structure might be a COSCOM.

Alternative Brigade Designs
Impact on Theater Sustainment Requirements

The Problem

- The logistics capability of different BDE structures differ and create unique support requirements for their higher echelon sustainment organizations

Findings

- Different BDE structures have different organic logistics capabilities
- The sources of back up support (non-organic) to these different type BDEs differ

Recommendations

- Review and modify various BDE/UA designs to standardize organic logistics capabilities (TRADOC)
- Design Sustainment UAs to accommodate BDE/UA LOG capabilities shortfalls (TRADOC)

We examined the various BDE level force designs to determine their logistics capabilities. There are shortfalls in all of them but the shortfalls are not consistent between them. Further in examining where the organic logistics shortfalls would be satisfied, these locations also differed. This complicates both planning and execution. BDE Support organizations for Objective Modularity and FCS should be the same with respect to the Logistics Functions shown on the next chart.

Impact of Alternative Div/Brigade Support Design on Theater Sustainment Rqmt's

Log Functions

	AOE	Force XXI	STRYKER	Interim Modularity	Objective Modularity
Water Production	Yes (MSB)	No (Corps)	Yes (BSB)[1]	Yes (BSB)[1]	Yes (BSB)[1]
Water Distribution	Yes (MSB)[2]	No(Corps)	Yes (BSB)[1,3,4]	Yes (BSB)[1,3]	Yes (BSB)[1,3]
Ammo Storage	No (Corps)	No (Corps)	Yes (ATHP)[5]	Yes (ATHP)[5]	Yes (ATHP)[5]
Fuel & Elec Maintenance	Yes (MSB)	No (Corps)	No (Corps)	No (SUA)[6]	No (SUA)[6]
Machinist Capability	Yes (MSB)	No (Corps)	No (Corps)	No (SUA)[6]	No (SUA)[6]
Back-up Maintenance	Yes (MSB)	No (Corps)	No (Corps)[7]	No (SUA)[6]	No (SUA)[6]
Brigade Level Mental/Envi. Health	No (MSB)	Yes (BSB)[1]	Yes (BSB)[1]	Yes (BSB)[1]	Yes (BSB)[1]

Notes:
( ) indicates lowest level functions is found.

1. Brigade Support Battalion (BSB).
2. Capability to transport water in SMFTs/blivets.
3. Capability to transport water in HIPPO/blivets.
4. Currently SCBT has FAWPS ILO HIPPO. HIPPO is currently unfunded.
5. Ammo transfer and handler points (ATHP) can handle 14 stons.
6. Theater Sustainment Command Sustainment Unit of Action (SUA).
7. STRYKER has no capability to conduct Scheduled Maint. Relies on Corps.

This chart shows the details of the previous discussion.

Air Force Agile Combat Support

Findings

- Air Force developed support provider packages
  - Modular, scaleable, and built from the bottom up based on the numbers and types of aircraft/platforms they support
  - Integrated into each deploying Air Expeditionary Force
- Army deploys by unit rather than by platform

Recommendation

- Apply a bottom up analytical technique, similar to the USAF Agile Combat Support methodology to determine required non-organic support elements. Tie to identifiable combat units with a goal of providing scaleable and modular combat support elements that are automatically associated with the various combat elements being developed in the evolving Modular Brigades (TRADOC)

Air Force “Agile Combat Support” is an analytic technique by which Air Force logistics support is tied to deployable aircraft/platforms. In a deployment, as aircraft are selected, their support requirements are automatically selected. Hence, an Air Force TPFDD is built by aircraft/ platform with its support structure automatically built from a predetermined database. "Agile Combat Support" is not directly transferable to an Army application. However, the concept of a scaleable and modular combat support package is an absolutely essential element of the evolution to modular Brigades. “Plug and play” logistics capability that is focused and adapted to the deploying combat force is a force multiplier.

Early Use of LOGCAP

The Problem

- Precluding the availability of initial LOGCAP personnel deprives the Army of critical services

Findings

- Logistics Civilian Augmentation Program (LOGCAP)
  - Provides civilian contractors for CS/CSS services
  - Includes USAR LOGCAP Support Unit (about 100 officers) to interface between operators and contractors - mobilization complicated
  - AMC deployed Team LOGCAP Forward (planners, contracting officer and contractor liaison) during early entry
  - Does not reduce the need for early entry military personnel for theater opening and RSOI
- 2400 LOGCAP personnel in Kuwait in Dec 02; 3000 at start of OIF in Feb 03.
  - A Corps Support Group (5 battalions -- about 3000 personnel) would be needed to provide equivalent support

Recommendations

- Do not replace available LOGCAP capabilities with AC units (G3, G4)
- Have LOGCAP in place, and allow early deployment of Team LOGCAP Forward to begin contract execution (AMC)
- Provide for rapid mobilization of LOGCAP Support Unit (AMC)

Intra-Theater Logistics Distribution

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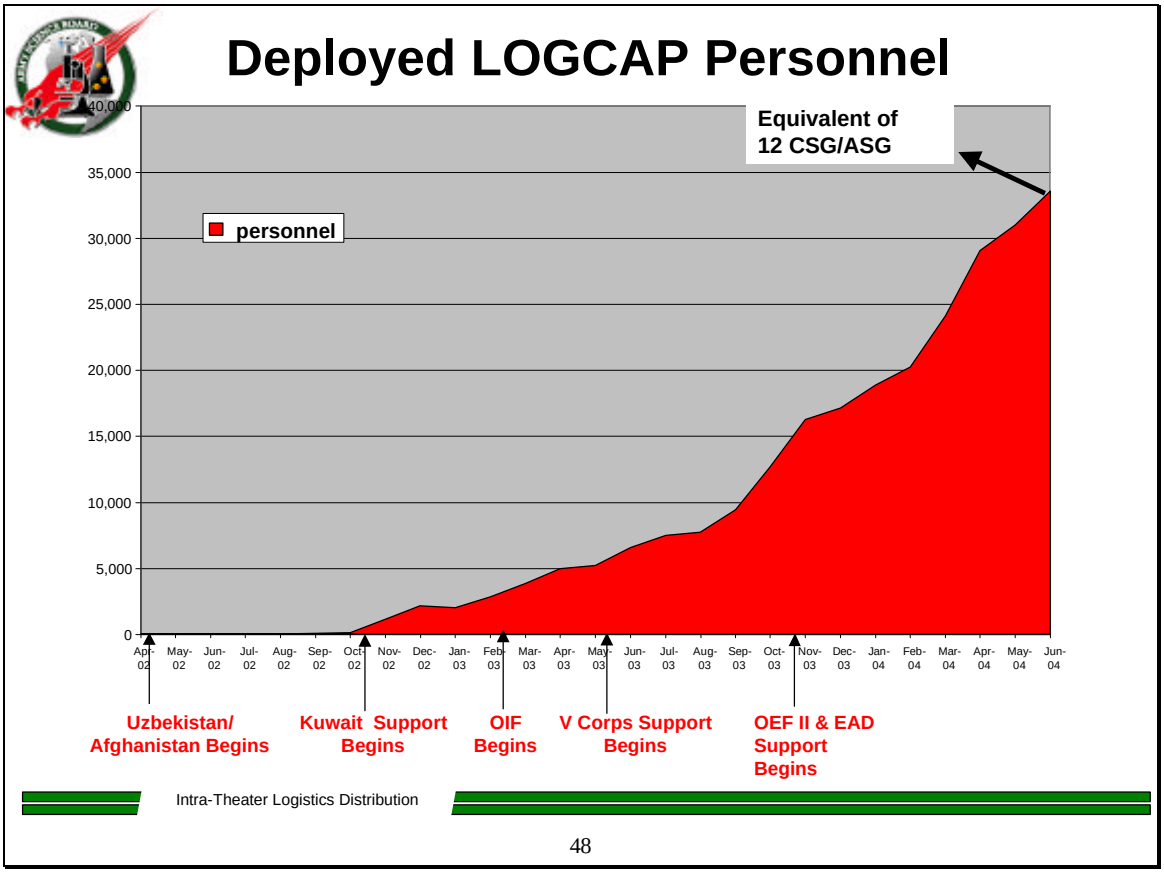
Logistics Civilian Augmentation Program (LOGCAP) is a program to provide civilian contractors for CS/CSS services, including housing and base support (Force Provider Modules), in wartime and other operations. Administered under a ten year, no cost ceiling Umbrella Support Contract, currently in third year with Kellogg, Brown & Root (KBR).

LOGCAP activities prior to C+30: construction/emplacement of bed down facilities, force provider modules, dining facilities; initial transportation and distribution system; materiel management and movement control; port opening; workforce and equipment to support APODs and SPODs; set up initial inland petroleum distribution system; RSOI; transportation for initial forces

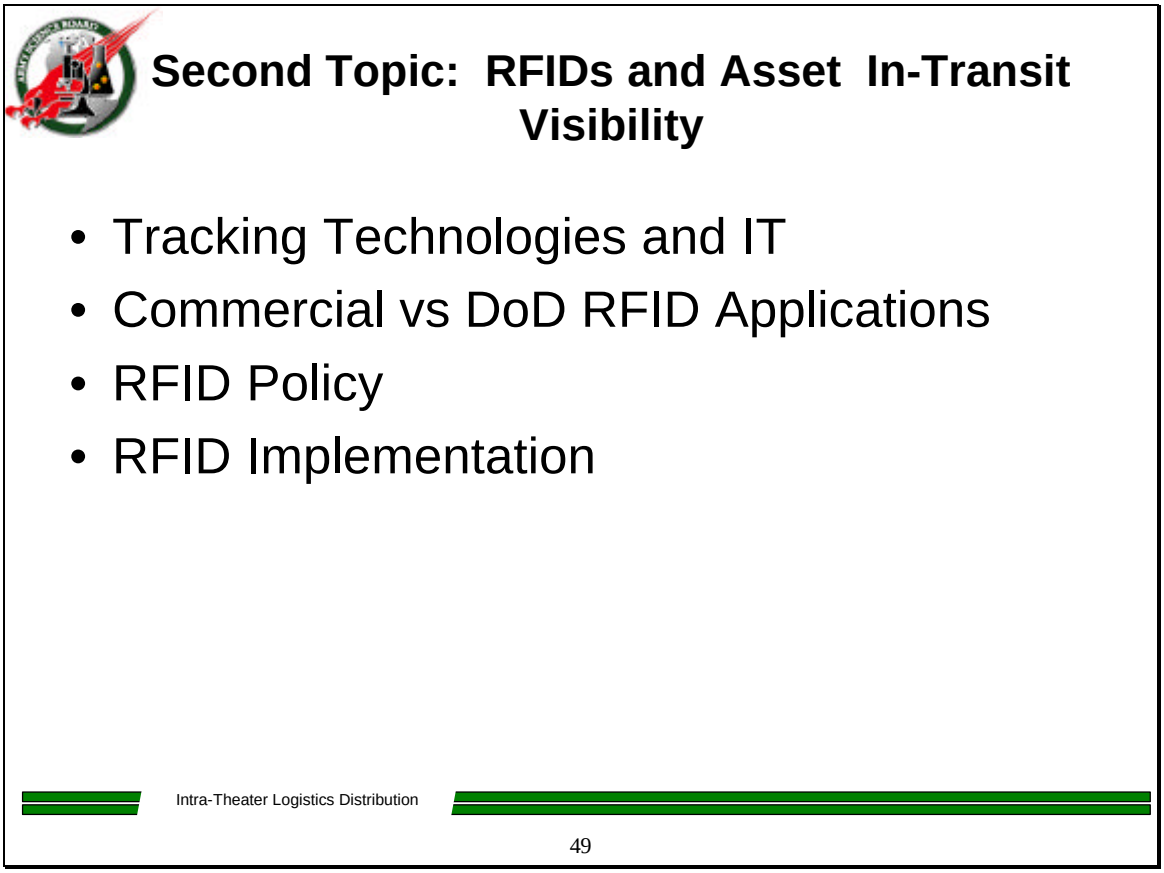
USAR Logistics Support Unit
This is an Army Materiel Command unit commanded by a board-selected USAR colonel. Consists of officer logisticians who also have Contracting Officer's Representative (COR) level of contract knowledge.

Part of pre-entry initial planning team and provides continuing interface between operators and contractors. There are 15 to 20 of these officers in country at any one time.

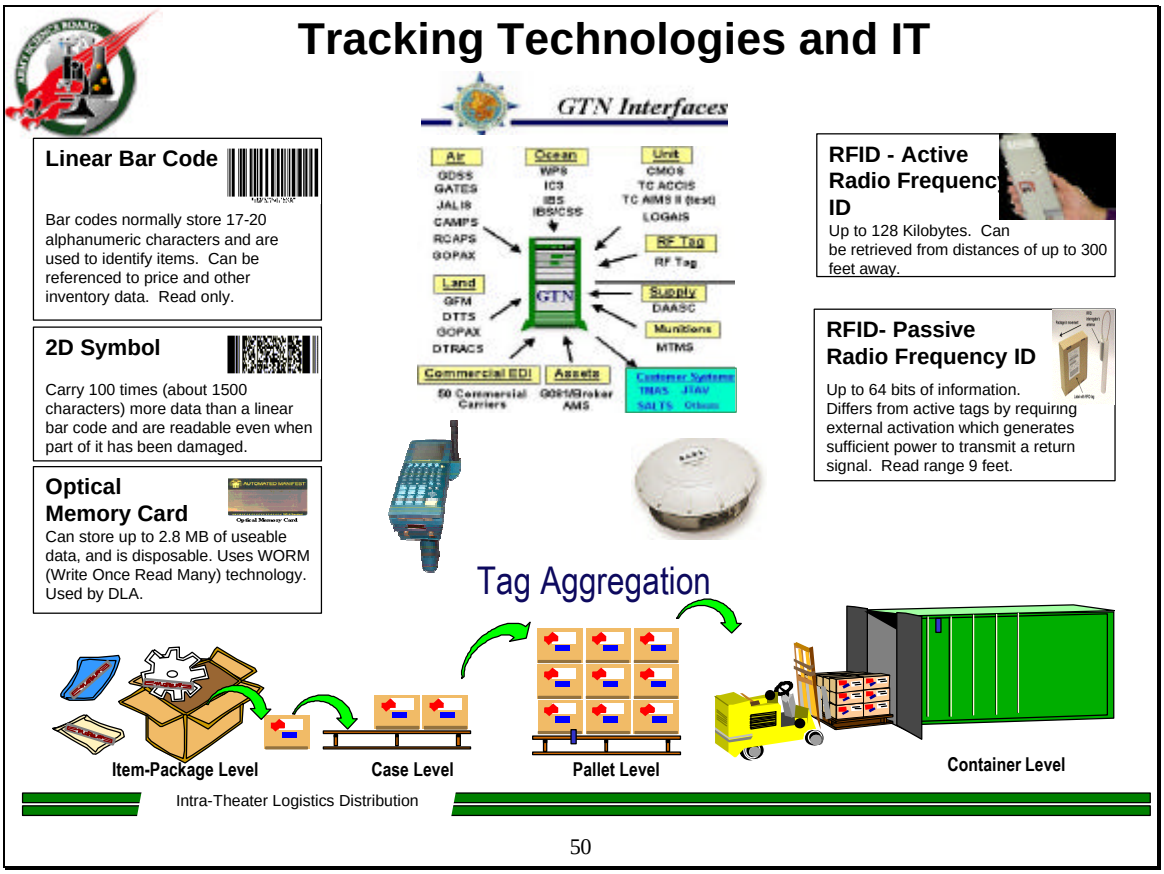
Mobilizing this unit requires approval from multiple agencies and complicates the early planning and entry requirements.



This chart shows the growth of LOGCAP contracted support personnel. It does not include civilian personnel contracted outside the LOGCAP contract vehicle. Delaying early implementation of LOGCAP would require active duty personnel to provide a similar capability.



Our next section addressed Radio Frequency Identification (RFID) and asset in-transit visibility. We will discuss each of the listed topics.

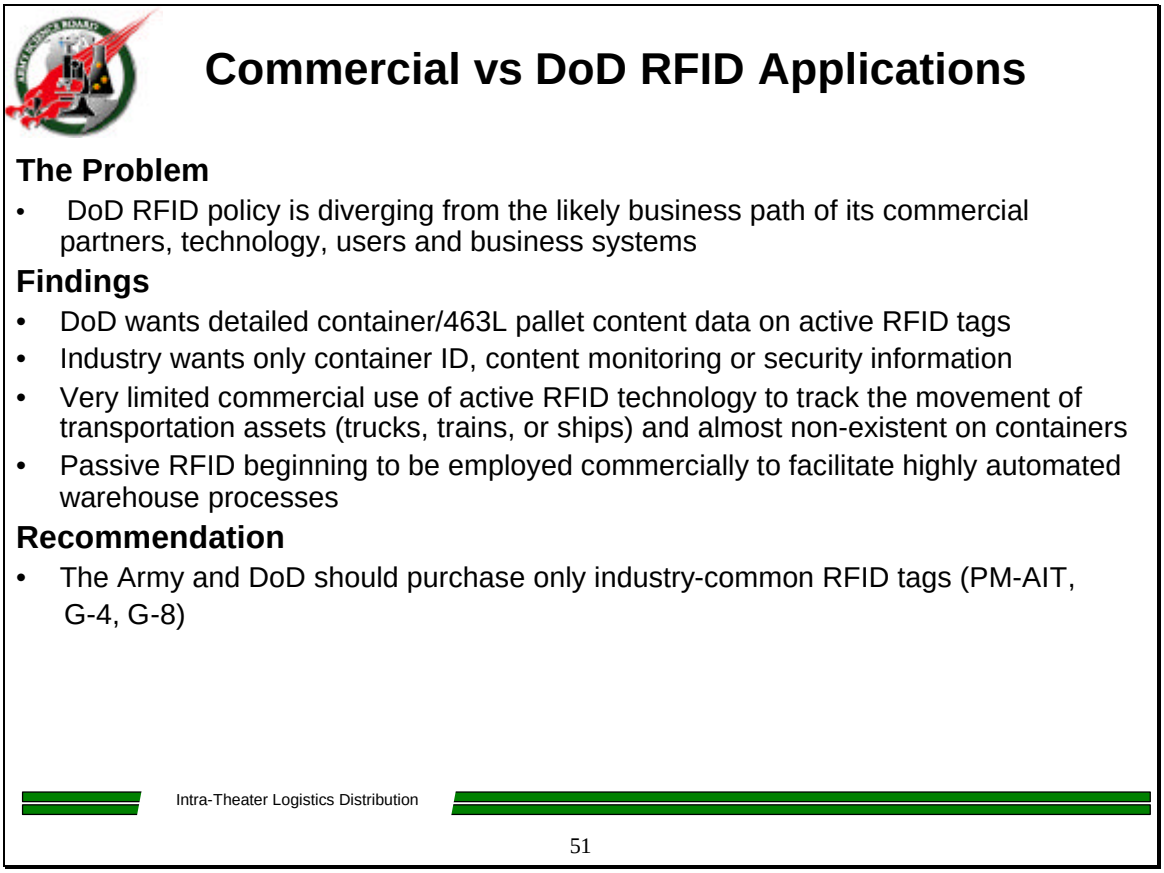


Industry uses two different kinds of bars codes shown above. The Army and DLA use optical memory cards with 2.8MB of data for shipments originating at DLA. This memory is used to record manifest data of shipments.

Active RFID tags contain 128 KB of memory and can be read from 300 feet away while the passive tag only contains 64 bits of data (an FSN) and can be read from 9 feet away.

RFID is another identification technology available in passive form with only 64 bites of information storage and active form with 128kb of memory.

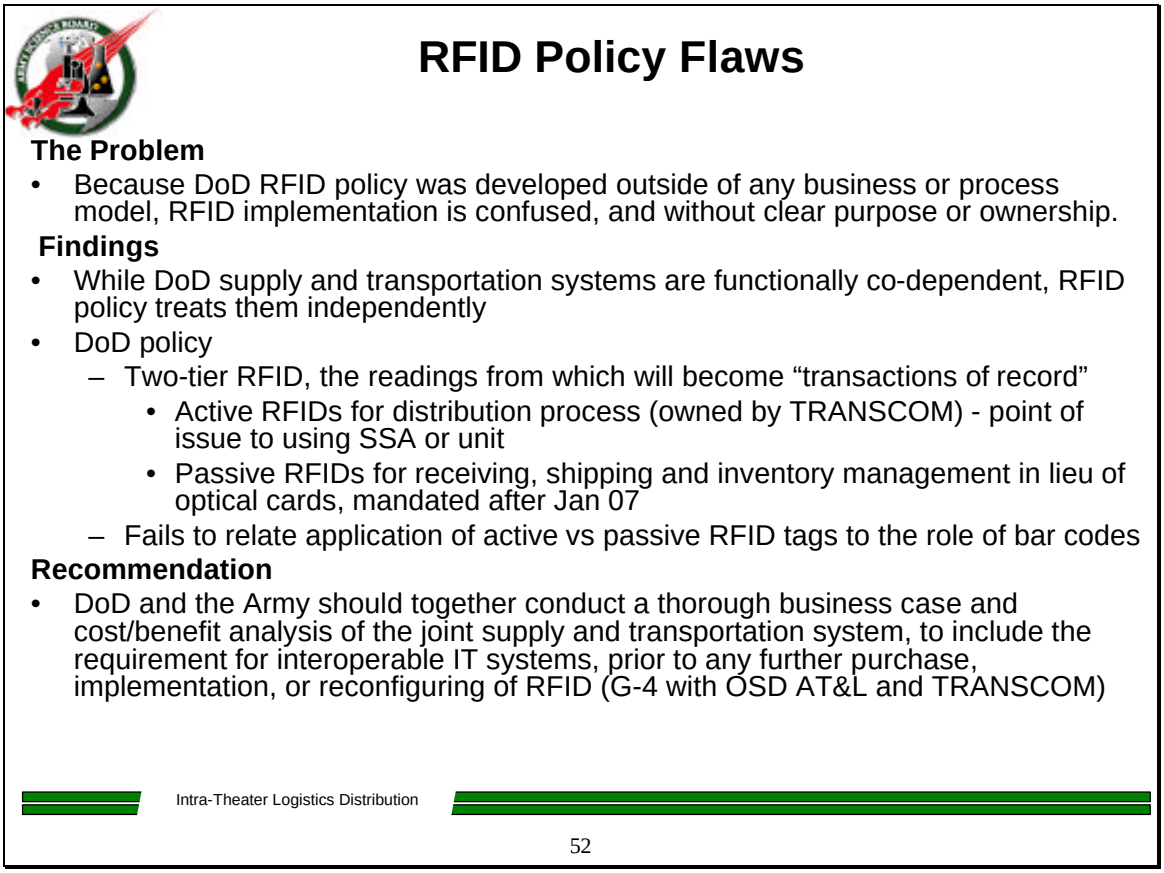
The information systems and technologies that attempt to integrate information from these devices are shown in the center of the chart. That integration is very incomplete at this time.



While DoD has attempted to build on commercial practices for RFID technology, the DoD policy is diverging from that of commercial users. For example, the DoD wants detailed content information on 463L pallets and containers using active RFID tags.

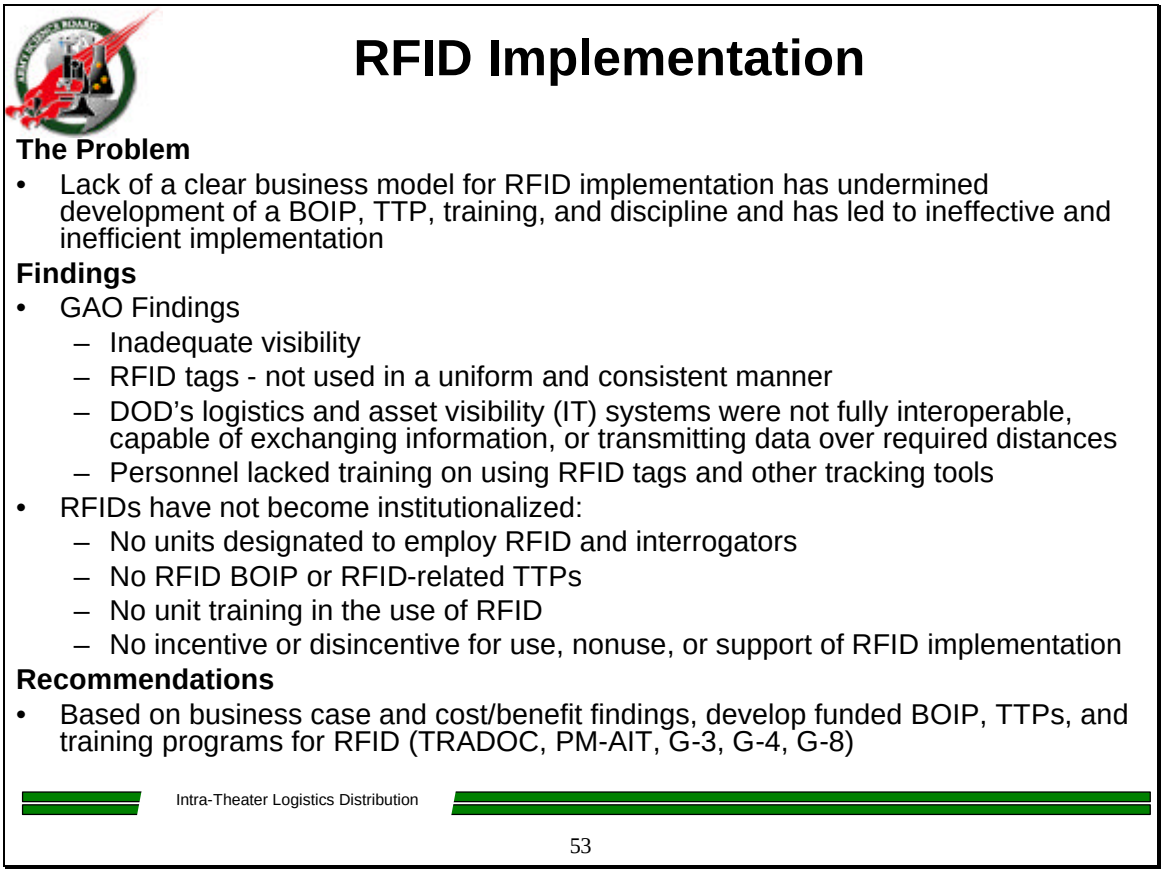
Industry does not want container content information available because of pilferage issues. Industry is interested in using RFID tags for monitoring container security and internal environment. There is little commercial use of active RFID to track movement of containers.

Walmart and other large commercial enterprises are beginning to use passive RFID in highly automated and controlled facilities.

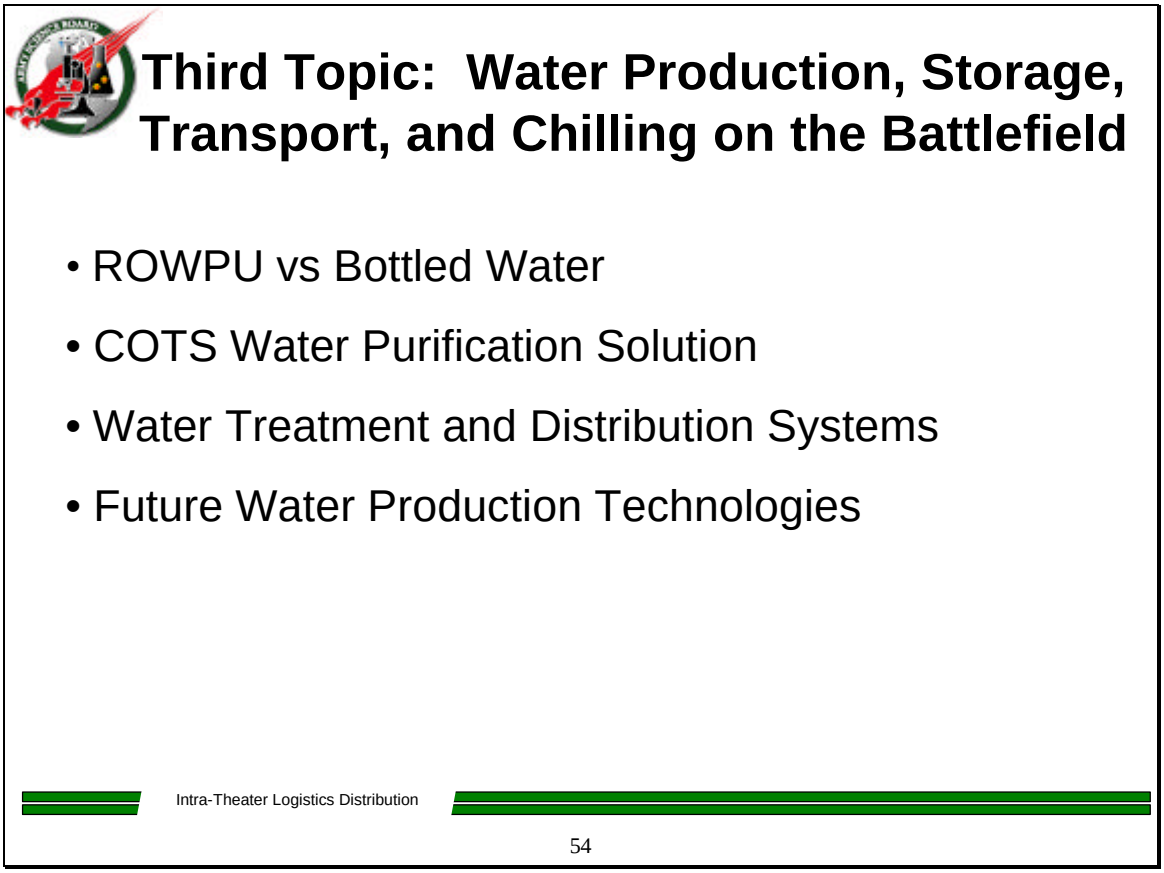


No business case or process model proceeded the DoD RFID policy formulation. Consequently RFID implementation throughout the Services and DLA lacks function and purpose. The benefits of the recently awarded large DoD contract ($238M) for RFID technology will not be realized until the function and purpose are identified and documented as integral parts of the supply and transportation process.

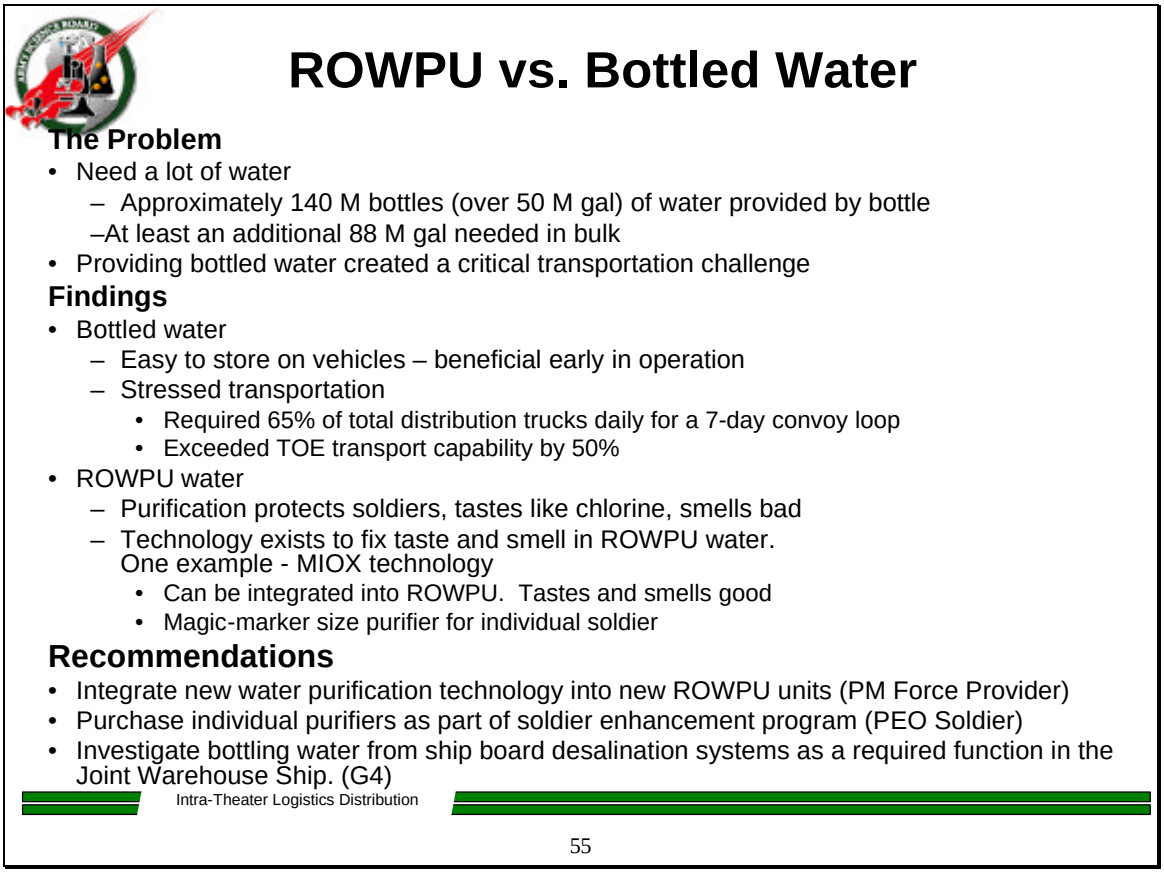
One immediate concern is how a 64 bit passive tag can replace a 2.8MB optical card without a significant change in the purpose for which these tags are to be used.



Because there is no DoD business model for RFID implementation there has been no development of the necessary Basis of Issue Plans (BOIP), or Tactics, Techniques and Procedures (TTP). Without BOIPs and TTPs implementation has been both ineffective and inefficient as indicated in the above GAO findings. Our overall bottom line conclusion with respect to RFID is that it is a "technology searching for a concept". This is not to underestimate the potential of RFID but to argue that its potential cannot be achieved without a clear understanding of its integrated use in the supply and transportation system.



The third section of the report deals with water. The listed subjects will be covered.



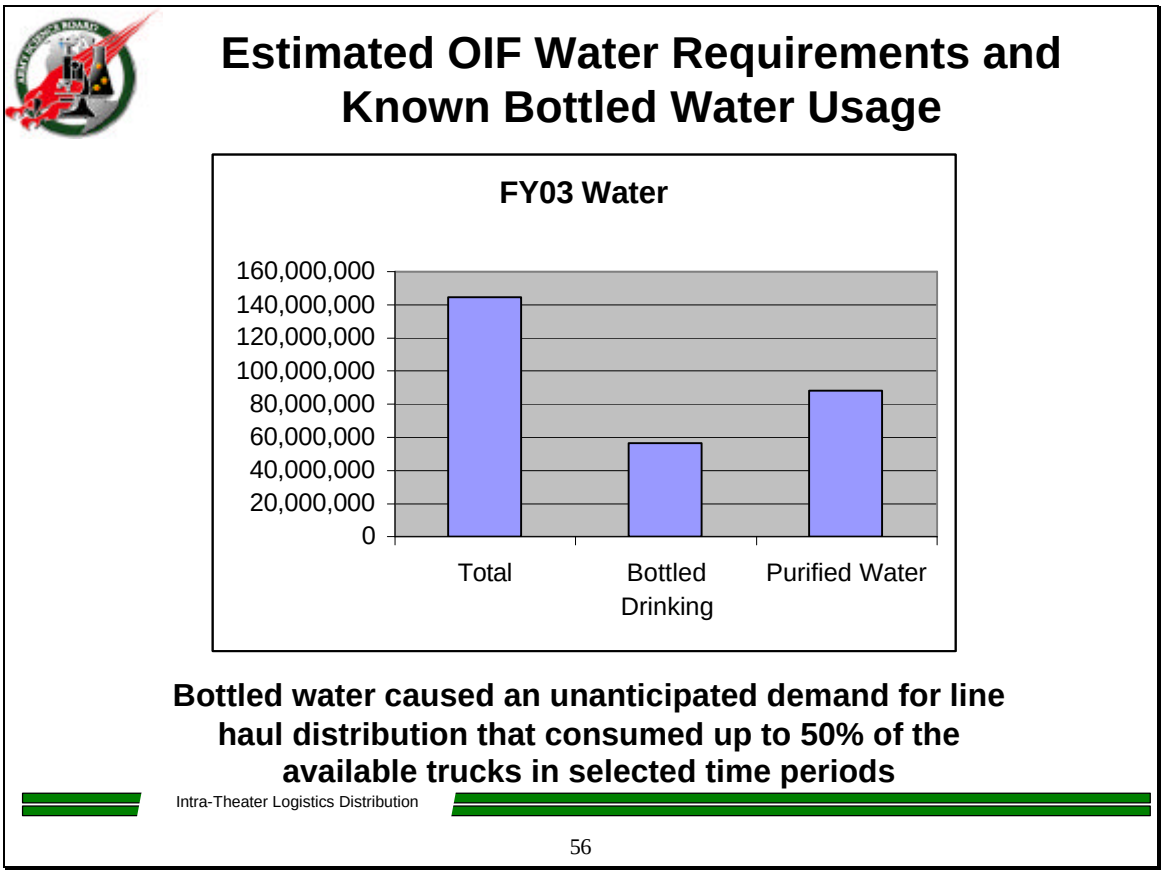
Based on the data available on bottled water consumption and the requirements for total water in an arid sustainment condition, 88+ M gallons of water was processed by ROWPU units in addition to that provided by bottled water. Uses for this water was for all purposes ranging from drinking, field sanitation and field feeding to vehicle maintenance. The details of water generation in the 101st ABN Div validated this data. Distribution of the bulk water to the units presented its own set of problems in availability of water buffalos and the soldiers use of additives into the water to offset the taste.

To protect the water supply, and to control water related disease, the surgeon General requires that the chlorine levels be brought to 2 PPM purification prior to distribution. This allows the water to maintain a chlorine residual of 1 PPM at the time the soldier draws it from the distribution device. Water contamination from soldier additives into Camelback devices and canteens without through cleaning accounted for specific examples of dysentery.

A side benefit of bottle water was the capability that it provided platform crews to cram water bottles into every available space on the interior of the platform. This technique provided more water available to the crew in a useable form than the externally mounted Jerry cans or the towed water buffalos. In the early stages of OIF, before water units arrived in the area of operations, bottled water was the principal source of potable water.

There are current technologies that can be applied to evolve the water purification and distribution process to non-chlorine purification. These include:

Integration of new technologies to offset the use of chlorine, provide soldiers with approved individual purification devices, pursue the capability to package at the water purification point to support soldier requirements



In seeking a baseline of water usage and requirements, we encountered a lack of data. There is a large body of data of which units were deployed but little data as to actual water produced. The best data available came from the 101st Abn Div on the usage of bottled water and ROWPU produced water, this data was published in "On Point" by CALL. Using this data and soldier based requirements data provided by CASCOM, we have derived the overall requirement for water in OIF for FY03. Overall the derived requirement for water based on the Sustainment water requirements in an arid environment, the is 144M gallons. Documented purchases of bottle water in this period was 56M gallons in 1.5 liter bottles.

Each case of bottled water contained 12 one and a half liter bottles. 60 to 65 cases can be loaded on a 40ft flatbed tractor trailer. Due to plastic water bottles collapsing under weight, neither the volume or weight limits of the 40' trailer can be achieved. The distances involved require a three and a half day trip each way for a total of seven days before a trailer can be reused. In this case the theater requires 60 to 65 trailers, seven days a week, (420 to 450 total) to cover the daily bottled water requirement. Water came from 3 regions in the theater. With a six day turn for each convoy over 50% of the total trucks available in theater for distribution were used for water in selected periods.

COTS Water Purification Solution - MIOX

Technology Description:

- MIOX electrolytic disinfection process to replace chlorine disinfectants
- DARPA Developed
- Prototypes tested at independent laboratories demonstrating removal of bacteria, viruses, and protozoan cysts
- More effective and eliminates the need to transport and store hazardous chemicals

Versions:

- Miniaturized version (3.5oz) fits in a "pen" or "cap"
  - Commercially sold
  - In the GSA catalog
  - Being purchased by USMC
  - Accepted as a Soldier Enhancement Program (SEP) candidate
- Large-scale system
  - Approved by EPA for municipal water treatment facilities
  - Prototype fabricated for 3,000 GPH ROWPU undergoing testing at TARDEC

Pocket

Camelbak

ROWPU

Intra-Theater Logistics Distribution

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DARPA and TARDEC funded MIOX Corporation to downscale their technology to provide a disinfection unit for individual use. The individual use purifier (shown above) is available through the GSA catalog. It is produced in the Mountain Safety Research family of products and is sold through various outlets such as REI, Eddie Bauer, and Campmor. For military applications, the purifier can come in desert brown or a green camouflage pattern.

MIOX Corporation uses a patented technology for purifying and disinfecting non-saline water. The non-hazardous process uses salt, water and electricity. The product is a solution of mixed oxidants. The mixed oxidant solution eliminates the objectionable taste and odor of the chlorine. The MIOX kills pathogens such as Giardia and Cryptosporidium, chemical and biological agents including Anthrax and achieves ten times the inactivation required in the EPA's "worst case" water.

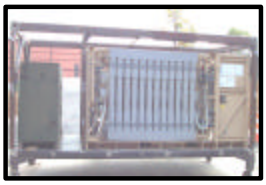
The individual unit can treat any non-saline water source to produce safe, odorless water without a chlorine taste. The purifier can be used to treat water at the point of consumption. As the chart shows the technology exists to purifying water for camelbaks and other soldier portable containers. The technology removes contamination picked up from containers throughout the military supply chain. The purifier can also treat indigenous water – from local villages, wells, rivers, or creeks -- when on patrol or reconnaissance. The USMC is procuring the individual devic7es.

MIOX Corporation sells large commercial disinfection units to municipalities for use in water treatment plants. This technology is being used to disinfect water supplies in numerous countries

and throughout the US. Examples of cities using this technology are Boulder, CO; Santa Fe, NM; and Panama City Beach, FL. Various DOD entities have incorporated the technology into military applications; e.g., TARDEC into ROWPUs, USN aboard carriers.

Water Treatment and Distribution Systems

New water treatment systems
(Reverse osmosis; Microfiltration)



Tactical Water Purification System (TWPS)
1,500 GPH

Lightweight Water Purifier (LWP)
120 GPH

New water distribution systems

Hippo - LHS Water Tankrack System 1500G

Camel - Unit Water Pod System 900 G

Findings

- Smaller footprint and less consumables required for generation
- Hippo eliminates safety issue and frees up transportation assets; Camel provides chilled water to the soldier

Recommendations

- Introduce technology to reduce chlorine from the ROWPU process (TARDEC/PM Force Provider)
- Procure the new water treatment (with new purification technology) and distribution systems (PM Force Provider) and align fielding plan to support Army modular initiative (G-3, TRADOC)

Intra-Theater Logistics Distribution

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There has been an active program to improve the capabilities fielded to the Army. The two initiatives that have yielded the best results are the Tactical Water Purification System (TWPS) (1,500 GPH) and the Lightweight Water Purifier (LWP) (120 GPH). The TWPS can deal with turbidity at the 45k parts per million. The TWPS is an ISO standard configuration and fits on any lift asset that can deal with a 20 foot container. The TWPS is issued to the Brigades on a basis of 1 TWPS for 2 600 GPH ROWPU. The LWP is air drop able, sling load capable, and can be loaded in the back of a HMMWV. In both cases, the devices use less chemicals in the chlorination process, have a more efficient and durable filtration system, and require fewer people to operate.

The remaining issue to be resolved is the taste issue while maintaining the safety of the water in distribution. The MIOX process as discussed offers an alternative process for water treatment that does not carry the taste and smell penalty. This is under investigation by TARDEC for inclusion in the TWPS. It is in use within the US Navy on aircraft carriers for the final treatment of water.

However, the current buy of the TWPS is not sufficient to issue a set to each Brigade as it converts to a Modular Unit.

Future Water Production Technologies

Findings

- Foreign Alternatives
  - Following the US lead on ROWPU technology
  - Canadian forces - some interesting packaging approaches
- Alternative Sources for water
  - From Vehicular Exhaust (TRL 6; 9 cubic ft; 300 pounds)
    - Not correlated with usage requirement – requires storage
    - Storage may contribute to survivability solution (increased ballistic protection)
  - From Air (Less than TRL 6)
  - Filtering
    - Inorganic membrane process (Greater than TRL 6). Scaling is the challenge
    - Reversible wetting in nanopores (Less than TRL 6). Tested at 1.3 liters/day

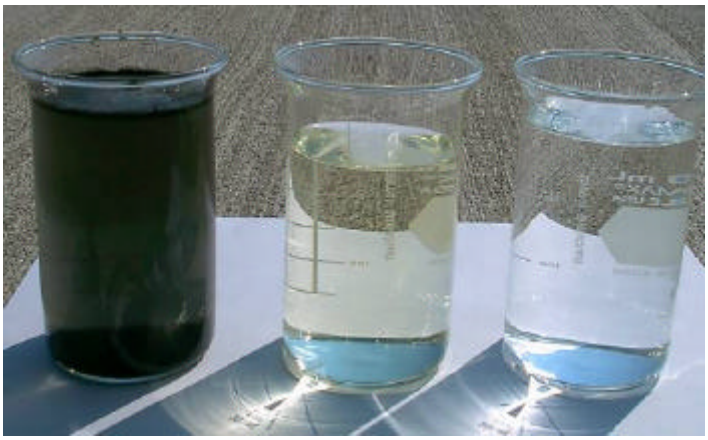
Recommendations

- Pursue development of water from alternative sources (TARDEC)
- Pursue alternative water packaging initiatives (G4)

Another initiative that was tried but did not come to fruition was the use of the Wildcat bottling system. FORSCOM took the Canadian System and reconfigured it. Three of these reconfigured units were built by FORSCOM and used in Bosnia and Afghanistan. This was a by-product of a Canadian Armed Forces initiative. This approach needs to be pursued as it may provide the option of packaging in forms that are more efficient from the soldier's prospective.

One of the challenges of vehicular produced water is that the quantity produced does not correspond to the quantity needed by the crew of that vehicle. Secondly, vehicles currently do not have water storage capacity, although South Africa reportedly has used water as part of their vehicle protection system. Hence, in addition to developing alternative production capabilities, storing and redistribution needs to be addressed.

LexCarb Water Purification from Exhaust



Exhaust Condensate | **Particle Filtered Water** | **Carbon/Resin Purified Water**

Water from exhaust at the far left is clearly undrinkable but after filtration is very drinkable. Scaling to fit on platforms is a challenge as is Surgeon General approval.

Improvements in water processing technology are going to be more evolutionary that revolutionary. But water from fuel, water from air and better filtration offer promise. While water from fuel may be closest, water from air may offer more value if the energy required does not exceed the benefit. Other technologies that take on the filtration process may offer other opportunities. The inorganic filter will require scaling and may be subject to clogging. Nanopores are another opportunity that combines energy savings opportunities as well.

Water Distribution Systems

Facts Bearing on the Problem

Legacy System SMFT 3k & 5k

Transformation Systems

Hippo - LHS Water Tankrack System 1500G

Legacy distribution system deficiencies

- Is unstable if less than full (- 700G)
- Has no chiller or heater
- Ties up distribution assets

Camel - Unit Water Pod System 900 G

Findings

- Camel provides chilled water to the soldier
- Hippo eliminates safety issue and frees up transportation assets

Recommendations

- Procure and align fielding plan to support Army modular Task Force initiative (G-3, TRADOC)

Intra-Theater Logistics Distribution

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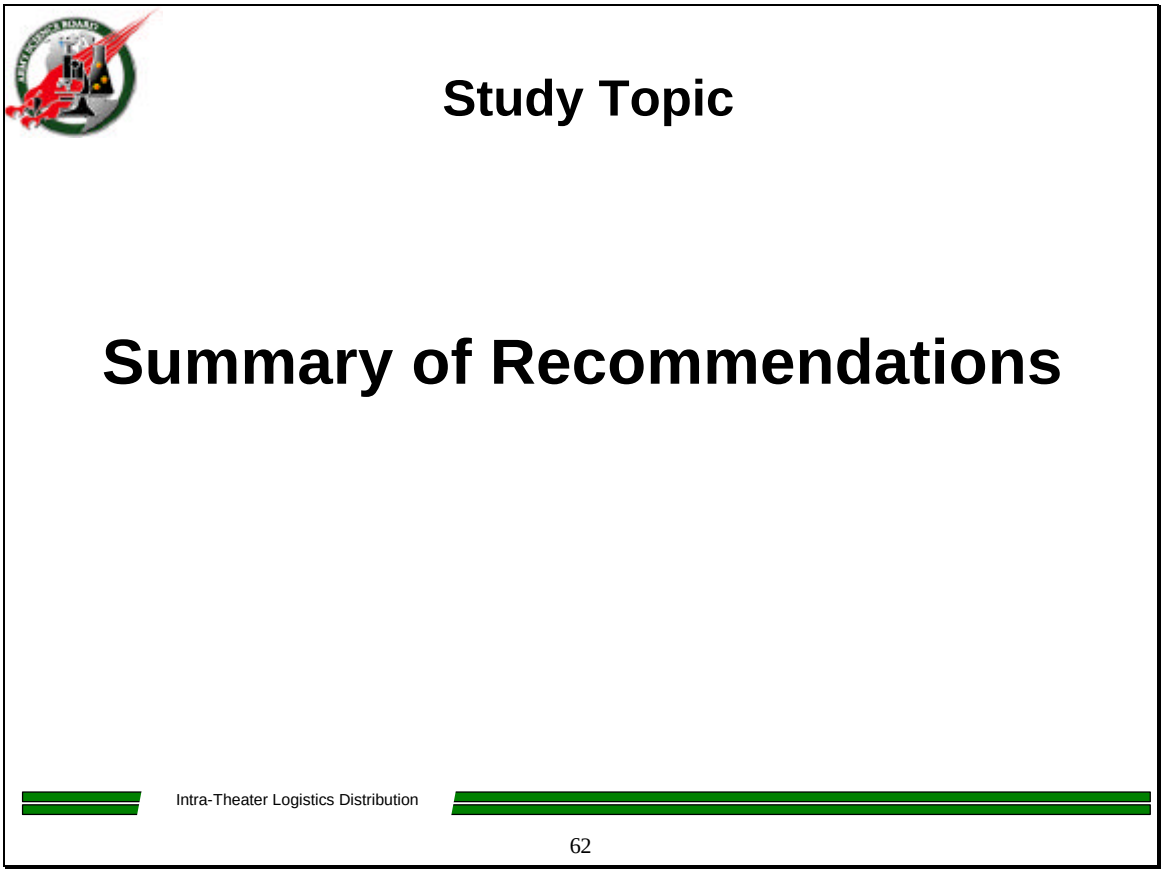
Current distribution devices consist of those designed for large quantities of water 3,000 gallons or 5,000 gallons semi-trailer mounted fabric tank (SMFT). The 3K SMFT fits on a 30 foot trailer and the 5k SMFT fits on a 40 foot trailer. In both cases, the SMFT becomes unstable for transport when 700 or more gallons are removed. This means that the trailer is tied up until the SMFT is emptied.

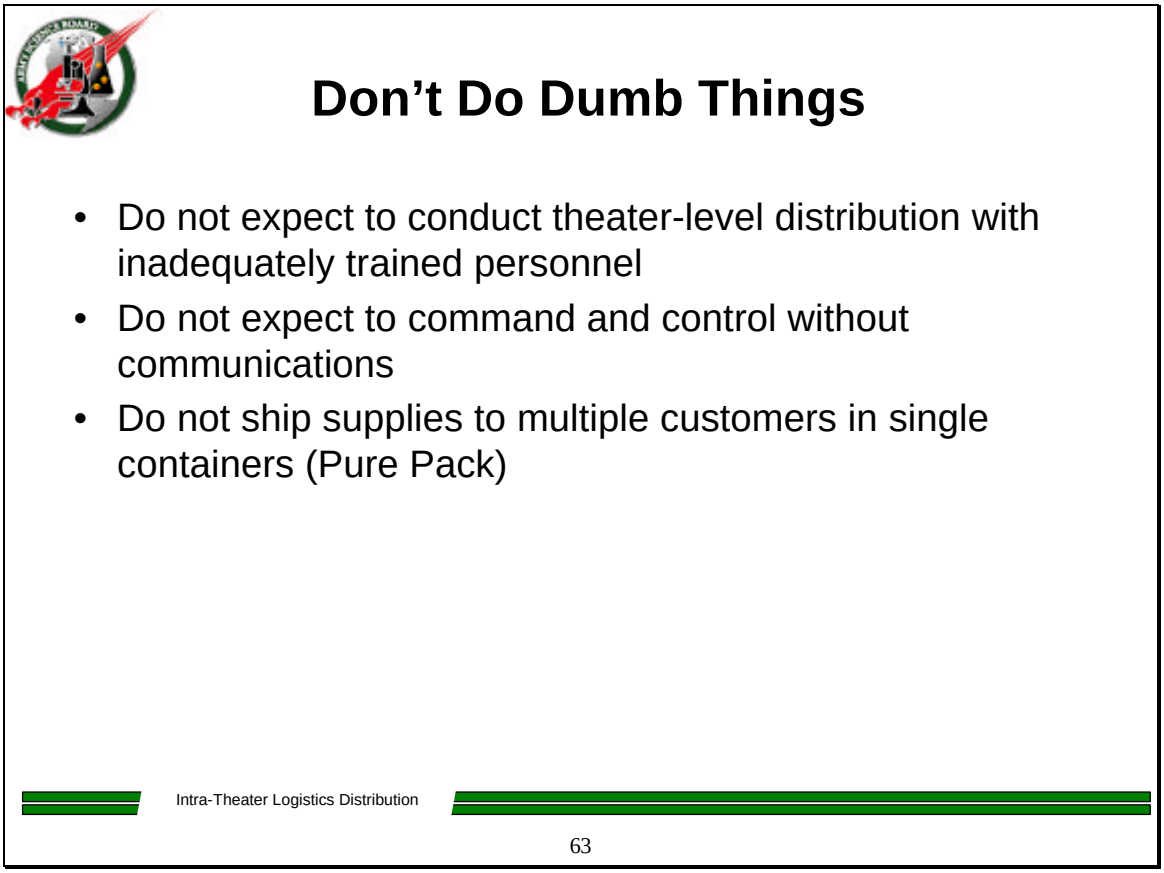
The using unit has the use of the 500 gallon water trailers and lister bags to provide distribution to individual soldiers.

New equipment that is coming on line will enhance the ability of the unit to deal with water. These are the Hippo, a 1,500 gallon ISO standard water tank that can maintain the water in temperatures down to -25 degrees and the Camel, a 900 gallon water trailer, that can heat and chill the water.

As with the TWDS, the issue is that procurement quantities do not match up with quantities required for all units to have the new equipment.



We will now summarize the major recommendations of this study.



Before summarizing the major recommendations of this study, it is important to point out three observations, which had major implications on the logistics operations in Operation Iraqi Freedom. These problems do not warrant a recommended action other than to caution not to repeat them.

- First, is that many problems occurred because personnel were deployed without the commensurate training essential for their successful performance.

- Second, many problems occurred in the conduct of logistics operations because logistics units and personnel did not have adequate communications.

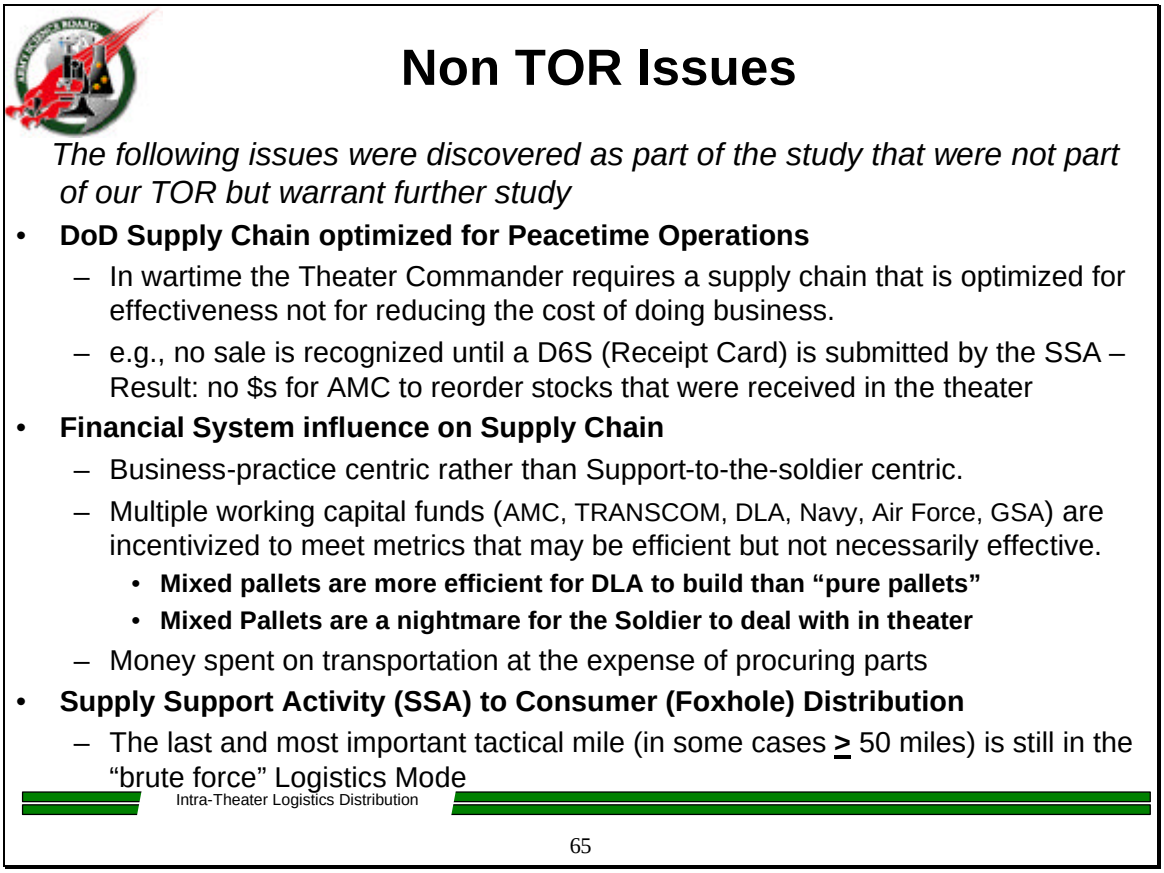
- Third, the shipment of supplies in containers and multi-pack, which contained items destined for multiple addressees, severely impaired distribution. This created an unresourced requirement for personnel to open containers or, more importantly, multi-packs, and then sort and redistribute these items. This resulted in shipping materiel to the wrong customers, or not shipping equipment for long periods of time because a breakbulk capability was not available. It took a year to resolve this problem completely.

None of these actions should be repeated in the future.

SUMMARY OF RECOMMENDATIONS

- Doctrine and Structure
  - Codify in joint doctrine the distinction between joint theater level logistics and land component/Army logistics requirements and the need for a joint theater-level logistics commander
  - Develop a Joint Theater Sustainment Command for assignment to CoCOMs
- Implement useful practices of other services
- Don't preclude early use of LOGCAP
- Complete a thorough business-based cost/benefit analysis of RFID before spending more money on it
- Fix the chlorination problem of ROWPU water

This chart shows our summary of recommendations, we believe that timely implementation will result in a more effective intra-theater logistics system for our combat forces. In other words have a logistics system that works in wartime. For too long, logistics improvements have been pushed to the right in the POM. Now is the time to implement vs. planting seeds for future lessons learned.



Our current logistics system does not transition to war. It is peacetime efficiency and financial rules based. The theater commander and the land component commander have to deal with multiple supply chains and multiple working capital funds. For example, TRANSCOM, DLA, and AMC all have Working Capital Funds. The funds cause the supply chain systems they resource to be efficiency vs. effectiveness based. The systems are optimized from a financial perspective which results in suboptimal performance at the consumer/soldier level. In other words, efficiencies at the "faxhole" (wholesale system) produced inefficiencies at the "foxhole". Break bulk operations were being performed in the theater because "mixed multi-pacs" were shipped from DLA. Because of backlogs of shipping the Susquehanna DLA Distribution Center hired 400 additional people. Metrics that measure Supply Chain performance are also peacetime/ efficiency oriented. The Customer Wait Time standards are focused on taking costs out of the pipeline. By sending mixed multi-pacs, Susquehanna was able to meet its CWT standard but pushed the requirement to break the multi-pac to the tactical level. The overall CWT actually increased. A better goal would have been that all pallets shipped to the theater would be "pure". "Pure" meaning all articles on the pallet were the results of requisitions from one SSA.

TRANSCOM has been designated the DoD Distribution Process Owner but doesn't own the Working Capital Funds that drive behavior in the multiple supply chain systems that "support" the Theater Commander. To integrate the Supply Chains we also need to integrate the Working Capital Funds.

In a well functioning supply chain, the SSA will fill customer requests (usually for single items), and DLA will fill SSA replenishment requisitions (usually for multiple quantities). For many reasons, including lack of obligation authority, the AWCF funded SSAs did not stock sufficient quantities of parts to fill customer requests for parts. Thus, each customer request was passed forward to DLA resulting in a vast increase in volume of requisitions to be filled by DLA. For example, DLA had to fill 10 customer requests for a part rather than fill 1 SSA requisition for 10 part to stock in the SSA.

The hand-off from the SSA to the consumer still remains a challenge. Too much "moving floppies" by ground transportation. As indicated, this is "brute force" logistics.

These above areas all warrant additional study because we have multiple supply chains that are not integrated, do not provide a capability that supports the rapid opening and follow-on sustainment of a Theater of Operations.

APPENDIX A

TERMS OF REFERENCE

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY
ACQUISITION LOGISTICS AND TECHNOLOGY
103 ARMY PENTAGON
WASHINGTON DC 20310-0103

15 MAR 2004

Dr. Joseph Braddock
Chair, Army Science Board
2511 Jefferson Davis Highway, Suite 11500
Arlington, Virginia 22202

Dear Dr. Braddock:

I request the Army Science Board (ASB) continue its efforts to further study the challenges facing the Army in distribution of supplies and materiel to the Central Command (CENTCOM) Area of Responsibility (AOR) and in future operations.

Background: The Army has substantial forces employed in the CENTCOM AOR and expects these forces to be so employed for the foreseeable future. The Army experienced problems distributing sustainment to these forces during Operation Iraqi Freedom (OIF) and some of these problems continue. The Army considers some of these problems to be systemic and in need of solution at the Department of the Army or Department of Defense level.

Issues for the Terms of Reference:

a. Adequacy of the Logistics Force required for Theater opening and initial distribution/logistics operations.

(1) Identify tasks required to open and initially support a Theater for combat operations.

(2) Examine Navy and Air Force methods of intra-Theater sustainment to determine if they have established any more effective or efficient logistics distribution policies/procedures.

(3) Evaluate the adequacy of the current logistics force given the assumption that no reserves will be deployed before C+30 and no Logistics Civil Augmentation Program (LOGCAP) available before C+30. Assess the best use of LOGCAP in time and functions, particularly as it conflicts with the C+30 assumption in performing Theater opening and initial distribution/logistics operations.

(4) Assess the adequacy of Army and Joint doctrine for providing these functions. Identify any changes in force structure required to meet the guidance above.

(5) Examine the impact on Theater logistics distribution capabilities associated with the design of organic logistics capability in the 3rd ID, Stryker Brigade Combat Team, and modular brigades.

(6) Evaluate the concept of creating a floating repair and supply capability afloat and the potential benefits of having such a capability.

b. Evaluate the proposed Deployment Distribution Operations Center (DDOC) Concept.

(1) Transportation Command (TRANSCOM) and Army Materiel Command (AMC) in coordination with CENTCOM have deployed a CENTCOM Deployment Distribution Operations Center (CDDOC) to support OIF. Examine the role for, the limitations of, and the metrics that could be used in performing the functions by the proposed CDDOC organization. Perform a review of CDDOC and Distribution Management Centers to identify overlaps and gaps in end-to-end distribution management, including visibility.

(2) Assess alternative Joint organizational structures that could be fielded to provide End-to-End distribution within a Combatant Command (COCOM) AOR. The resulting organization must have the structure, capabilities, and oversight to synchronize distribution processes impacting both force and materiel movements in overseas Theaters.

(3) Provide recommendations regarding the quantity, employment and the relation between the DDOC and other distribution management organizations to ensure this capability is provided. Recommend whether the CDDOC should be a permanent or temporary Theater capability.

c. Asset In Transit Visibility (ITV) and Management to include Automated Information Technology (AIT) Systems

(1) Survey AIT/ITV experts in the Army and Joint communities, preferably with recent experience in Operation Enduring Freedom (OEF) and OIF, and determine the problems associated with visibility of logistics assets in Theater including actions initiated in Theater to provide visibility to retrograde materiel.

(2) Survey technologies in use or development by the civilian and military sectors for application in the military environment. The goal is that the military's future asset tracking be a commercial technology that can be continually upgraded and improved as technology evolves under the rigors of the commercial market. This assessment should include the necessary writers, readers, communications and management software/processes associated with transit visibility.

(3) Assess the costs, challenges, operational (including logistical) impacts, and benefits of fielding these solutions to our forces in Theater in order to provide recommendations for Rapid Fielding Initiative (RFI), Advanced Concept and Technology Demonstrations (ACTD), Rapid Acquisition Programs (RAP), Non-developmental Items (NDI) or commercial-off-the-shelf procurements.

d. Production, Storage, Transport, and Chilling of Water on the Battlefield.

(1) During OIF, water was provided in bulk, produced by our Reverse Osmosis Water Purification Units, and in bottles procured commercially. Issues exist regarding production using large capacity ROWPU units, distribution of bulk water, distribution of bottled water, and provision of cool water.

(2) Assess current technologies for the production of pure water given that the sources of water may be small in size and scattered across a large area. Use experiences in OIF as the example.

(3) Assess current technologies in bottling, storing, transporting and chilling water; particularly in a container smaller than the current Semi-trailer Mounted Fabric Tank. Consider the resources required to distribute water.

(4) Provide recommendations for RFI, ACTD, RAP or NDI/COTS procurements.

Study Sponsorship: Assistant Secretary of the Army (Acquisition, Logistics and Technology), Deputy Chief of Staff, G-4 and AMC will be the primary sponsors. Contact these organizations to obtain study support.

Study Duration: Complete and report out study results in July 2004. Provide interim progress report in May 2004.

Special Provisions: Conduct the study within the provisions of Public Law 92-463 (Federal Advisory Committee Act) and appropriate Department of Defense and Army Regulations. It is not anticipated that this inquiry will go into any of the "particular matters" within the meaning of Section 208, Title 18 of the United States Code.

Sincerely,

Claude M. Bolton, Jr.
Assistant Secretary of the Army
(Acquisition, Logistics and Technology)

APPENDIX B

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PARTICIPANTS LIST

ARMY SCIENCE BOARD

2004 AD HOC STUDY

Intra-Theater Logistics Distribution in the CENTCOM AOR

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Dr. Marygail Brauner
RAND

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Logistics Management Institute

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Hancock Associates, Inc.

Mr. Richard Ladd
Robison International

LTG Charles Otstott (USA, Ret.)
Private Consultant

LTG Leo Pigaty (USA, Ret.)
Private Consultant

Mr. Donald R. Quartel
FreightDesk Technologies

GEN Leon E. Salomon (USA, Ret.)
Salomon Associates LLC

Government Advisor
Dr. David Schrady
U.S. Naval Post Graduate School

Staff Assistant to Study Chairs
COL Robert Carpenter
Office of the Deputy Chief of Staff G-4

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GEN Paul J. Kern
CG, Army Materiel Command

LTG Claude V. Christianson
Deputy Chief of Staff G-4

APPENDIX C

ACRONYMS

AFS	Auxiliary Food and Stores
AIT	Automated Identification Technology
ABN	Airborne
AMC	Army Materiel Command
APS	Army Prepositioned Stocks
APOD	Aerial Port of Debarkation
ARF	Army Regional Flotilla
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
AT&L	Acquisition, Technology and Logistics
ATHP	Ammunition Transfer and Handling Point
AWCF	Army Working Capital Fund
BDE, Bde	Brigade
BOIP	Basis of Issue Plans
BSB	Brigade Support Battalion
C2	Command and Control
CALL	Center for Army Lessons Learned
CASCOM	Combined Arms Support Command
CCP	Consolidation and Containerization Point
CDC	Corps Distribution Center
CDDOC	CENTCOM Deployment Distribution Operations Center
CFLCC C4	Coalition Forces Land Component Command Logistics Command
CIRF	Centralized Intermediate Repair Facilities
CMD	Command
CMMC	Corps Material Management Center
CMOS	Cargo Movement Operations System
COCOM	Combatant Command
CONOPS	Concept of Operations
CONUS	Continental U.S.
COR	Contracting Officer's Representative
COSCOM	Corps Support Command
CSB, R, F,	Corps Support Battalion, Rear, Forward
CSG/ASG	Combat Support Group / Area Support Group
CWT	Customer Wait Time
DARPA	Defense Advanced Research Projects Agency
DASB	Division Aviation Support Battalion
DCMAO	Defense Contract Management Area Office
DDOC	Deployment Distribution Operations Center
DIRMOBFOR	Director, Mobility Forces
DLA	Defense Logistics Agency
DMC	Distribution Management Center
DMMC	Division Material Management Center
DoD EA	Department of Defense Executive Agent
DOS	Days of Supply
DS	Direct Support
ECM	Electronic Counter Measures

EDI	Electronic Data Interchange
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
FAWPS	Forward Area Water Point System
FCS	Future Combat System
FLB	Forward Logistics Base
FOL	Forward Operating Locations
FORSCOM	(U.S. Army) Forces Command
FSB	Forward Support Battalion
G-3	Deputy Chief of Staff for Operations (Army)
GAO	Government Accounting Office
GPH	Gallons per hour
GS	General Support
GSA	General Services Administration
HIPPO	Load Handling System Compatible Water Tankrack System
HMMWV	High Mobility Multipurpose Wheeled Vehicle “Humvee”
HQDA G-4	Headquarters Department of the Army Deputy Chief of Staff for Logistics (G-4)
ILO	In lieu of
ICP	Inventory Control Point
ISO	International Standards Organization
IT	Information Technology
J-4	OSD Logistics Directorate
JCS	Joint Chiefs of Staff
JFACC	Joint Force Air Component Command
JFC	Joint Force Commander
JFCOM	Joint Forces Command
JIC	Joint Integrating Concept
JLCC	Joint Land Component Command
JMC	Joint Movements Center
JMCC	Joint Maritime Component Command
JTOE	Joint Table of Organization and Equipment
Kb	Kilobyte
KBR	Kellogg, Brown and Root
LANTIRN	(Low Altitude Navigation and Targeting Infrared for Night) navigation and targeting FLIR (Forward Looking Infrared) system
LCC	Land Component Command
LMI	Logistics Management Institute
LOGCAP	Logistics Civil Augmentation Program
LRU	Line Replaceable Unit
LSA	Logistics Support Activity
LTA	Logistics Transformation Agency
LWP	Lightweight Water Purifier
MB	Megabyte
MEF	Marine Expeditionary Force
MILSTRIP	Military Standard Requisitioning and Issue Procedures

MIOX	Mixed Oxidant water purification method (registered trademark)
MRO	Material Release Officer
MSB	Main Support Battalion
MSC	Military Sealift Command; Major Subordinate Command
MSRP	Mission Ready Spare Packages
MTBF	Mean Time Between Failure
MTW	Major Theater War
OIF	Operation Iraqi Freedom
OSD	Office of the Secretary of Defense
PEO	Program Executive Office
PM	Program / Project Manager
POD	Port of Debarkation
POE	Port of Embarkation
POM	Program Objective Memorandum
PPM	Parts Per Million
PWC	Purification Water Company
RFID	Radio Frequency Identification
RORO	Roll-On Roll-Off
ROWPU	Reverse Osmosis Water Purification Unit
RSOI	Reception, Staging, Onward Movement and Integration
SBCT	Stryker Brigade Combat Team
SDDC	Surface Deployment and Distribution Command
SMFT	Semitrailer Mounted Fabric Tanks
SO	Stockage Objective
SPOD	Sea Port of Debarkation
SPT	Support
SSA	Supply Support Activity
STAMIS	Standard Army Management Information Systems
SUA	Sustainment Unit of Action
SVC	Service
TARDEC	Tank and Automotive Research Development and Engineering Center
TCAIMS-II	Transportation Coordinator's Automated Information Management System II
TDC	Theater Distribution Center
TEU	Twenty-foot Equivalent Units (containerized cargo unit of measure, 20'long x 8'wide x 8.5'high)
TF	Task Force
TRADOC	Training and Doctrine Command
TRANSCOM	Transportation Command
TRL	Technology Readiness Level
TRL 6	Technology Readiness Level 6: System/subsystem model or prototype demonstration in a relevant environment. (for all TRLs see p.27 of 2001 ASB Ad Hoc Study "Knowledge Management")
TSC	Theater Sustainment Command; Theater Support Command
TTP	Tactics, Techniques and Procedures

TWDS	Tactical Water Distribution System
UA	Unit of Action
USA	United States Army
USAREUR	US Army, Europe, and Seventh Army
USAF	United States Air Force
USAR	United States Army Reserve
USN	United States Navy

APPENDIX D

STUDY EXECUTIVE BRIEFING

Army Science Board
2004 Ad Hoc Study

Intra-Theater Logistics Distribution in the CENTCOM AOR

As of 22 July 2004

Intra-Theater Logistics Distribution Study Organization

SA to Study Chairs
COL Bob Carpenter HQDA G-4

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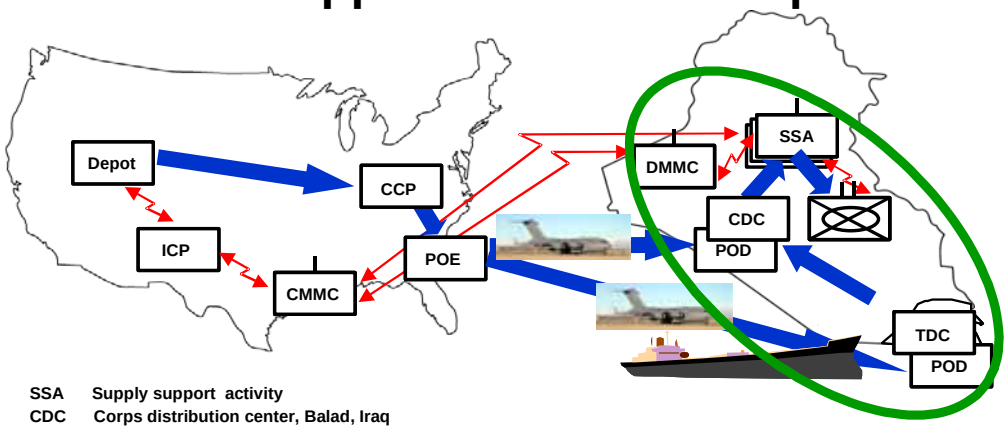
Lee Salomon	-	USA, Ret,	Logistics Consultant
David Schrady	-	USNPGS,	Professor OA

Distribution Nodes Providing Support to Units in Iraq



SSA Supply support activity
CDC Corps distribution center, Balad, Iraq
TDC Theater distribution center, Camp Doha, Kuwait
DMMC Division materiel management center
CMMC Corps materiel management center, 321st MMC, Baton Rouge
ICP Inventory control point
CCP Collection & containerization point, New Cumberland PA
POE Air and Sea port of embarkation
POD Air and Sea port of debarkation

- Transport within country
- Receipt and processing in overseas distribution centers
- Delivery to direct support supply activity
- Issue to customer unit

Study Scope

Study the challenges facing the Army in distribution of supplies and materiel to the Central Command Area of Responsibility and in future operations

- Forces for Theater opening and initial logistics operations, including the Deployment Distribution Operations Center
- Asset in-transit visibility and management
- Water production, storage, transport, and chilling on the battlefield

First Topic: Joint and Army Forces for Theater Opening and Logistics Operations

- **Joint theater-level logistic function, doctrine, and command authority**
- **Joint organizations**
  - Deployment Distribution Operations Center
  - Joint Theater-level logistics force structure
  - Theater Distribution Center
  - Command of Intra-theater Transportation
- **Logistics Practices of Other Services**
  - Other Service supply practices and Army supply afloat
  - Other Service repair and maintenance practices and Army repair capability afloat
  - Other Service in-transit visibility
- **Army/Land component logistics force structure**
- **Impact of alternative brigade force designs**
  - Other Service scaleable combat support
- **Early use of LOGCAP**

Joint Theater Level Logistics Functions

The Problem

- No agreement on joint logistics functions performed by/for the joint force commander versus those performed by component commanders to accomplish their mission

Findings

- Functions can be both joint and component; e.g., transportation
- Issue is who does it and for whom is the function being performed
  - Function requires means from multiple Services to perform it = joint
  - Function performed for multiple components = joint
  - Function performed by means of single Service for single component ? joint
- G4 and CASCOM are identifying functions that need to be performed by Service or Agency, but not distinguishing joint theater level functions

Recommendation

- The Army G-4, as the lead of the Joint Logistics, Joint Integrating Concept (JIC) must identify and codify the distinction between the logistics functions performed at the joint theater level vs. the service component level (G-4)

Adequacy of Joint Logistics Doctrine

The Problem

- Joint Doctrine is not current and does not clearly distinguish the theater opening/theater sustaining functions/tasks required at the Joint Force Commander level

Finding

- Twenty One Joint Logistics Pubs
  - Several need updating
  - Do not distinguish between joint and Service functions

Recommendation

- Aggressively support the development of joint doctrine to define the functions, command relationships, and organizations needed to perform joint theater logistics functions and the subset required for theater opening (G-4)

Joint Theater-level Logistics Command Authority

The Problem

- While the Joint Force Commander is responsible for theater-level logistics, no subordinate commander is charged with executing that mission

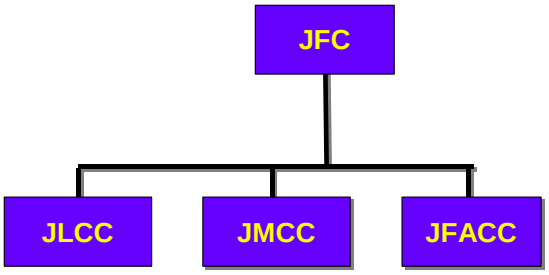
Finding

- Joint Commanders must exercise control over joint logistics resources
- No doctrinal requirement for a theater-level logistics commander

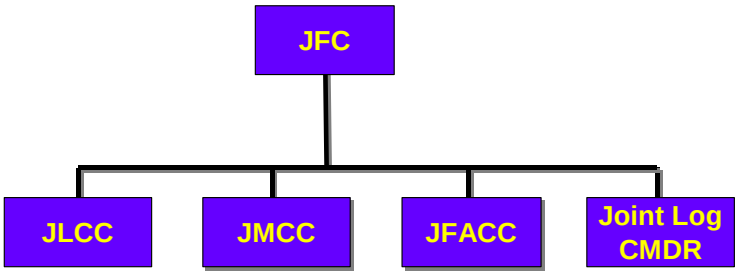
Recommendation

- Establish the doctrinal requirement to provide a joint theater level logistics commander to a theater-level commander when an operational mission is assigned (TRADOC with G-3)

Current Joint Command Structure



Providing a Joint Theater-level Logistics Commander



CENTCOM Deployment Distribution Operations Center (CDDOC)

The Problem

- The Joint Movements Center was not adequately resourced or its personnel trained to identify and resolve distribution problems in theater

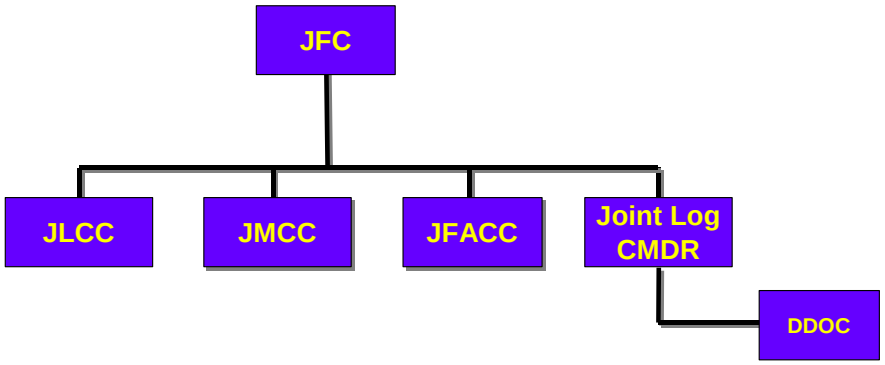
Finding

- The Deployment Distribution Operations Center was established as a staff element with joint representation to track distribution and resolve distribution management problems
  - Absorbed the resources and functions of the Joint Movements Center
  - Despite lack of command authority, DDOC was successful with staff of only 65 personnel
  - No approved and published JTOE exists for a DDOC

Recommendations

- Establish the JTOE and resource a DDOC for each CoCOM (TRADOC, J-3/G-3, G-4, G-8)
- Assign a DDOC to the Joint Theater-level Logistics Commander who has the authority to direct actions (J-3/G-3 with G-4)

Assignment of the DDOC to the Joint Theater-level Logistics Commander



Joint Theater Logistics Force Structure

The Problem

- The Service organizations needed to perform theater-level logistics operations have not been designated and assigned to joint commands and resulted in too many workarounds and impeded effective theater-level logistics support and C2

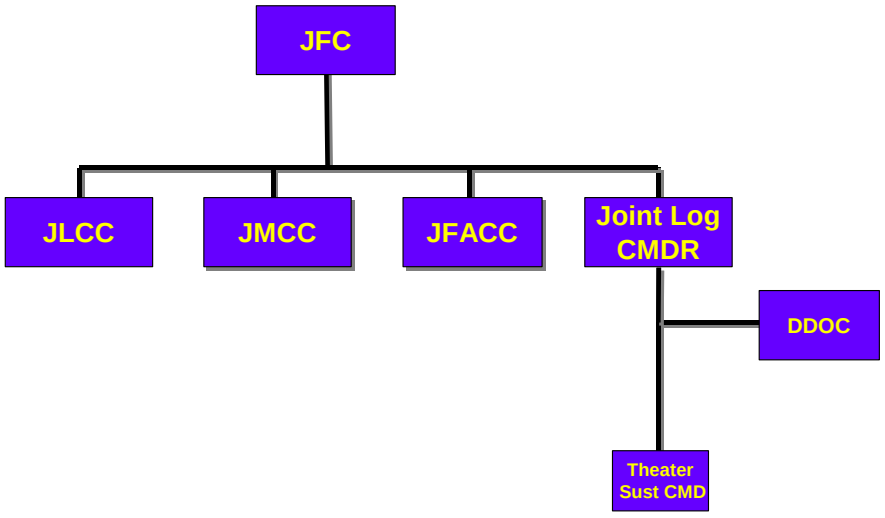
Findings

- Army logistics organizations are capable of performing most theater-level logistics functions but organizations that require other service personnel do not exist
- The organizations required to perform theater-level logistics need to be part of a single theater-level logistics command
  - G4 and CASCOM are developing an “Army only” Theater Sustainment Command (TSC) that is “Joint Capable”
- Forces required for theater opening are a subset of the force required to perform theater logistics operations when the theater is mature and therefore the Theater Opening and Theater Distribution BDEs should be part of the TSC

Recommendations

- Complete the development of a Joint Theater Sustainment Command and its subordinate elements and put it in the Army Campaign Plan (TRADOC, G3, G4)
- Activate at least two active component Joint Theater Sustainment Commands (G-3, G-8 and G-4)
- Develop the TOE of the Theater Opening BDE to consist of elements of the mature TSC. (TRADOC)
- Assign the Theater Opening BDE and Theater Distribution BDE along with other appropriate Service elements to the TSC (G-3, TRADOC, and G-4)

Theater Sustainment Command to accomplish Joint Theater-level Missions



Theater Distribution Center

The Problem

- All joint operations will require a Theater Distribution Center, but no TOE exists

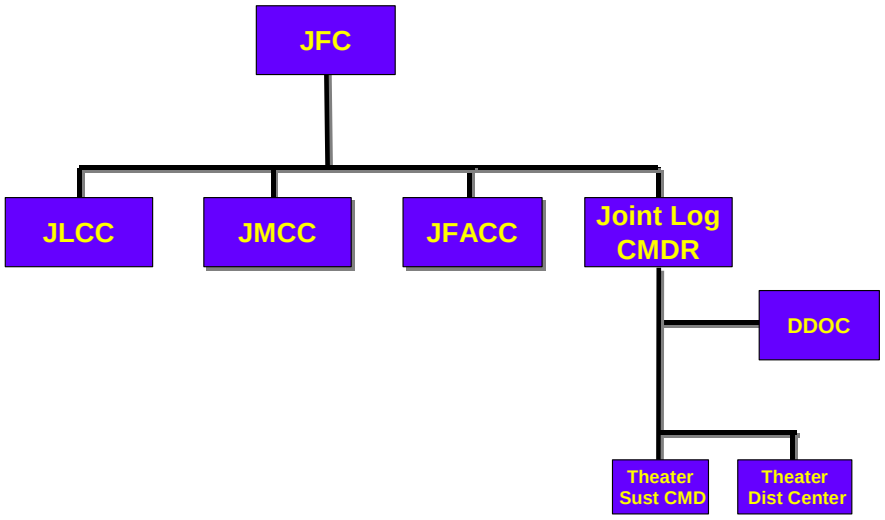
Findings

- Theater Distribution Center is required
- Function originally performed by Central Receipt and Storage Point in Kuwait
- TDC created in OIF with assets from TC BN HQ, GS Supply CO, Cargo Transfer CO, MCT, and Truck CO
  - Not organized to perform break bulk – requires “pure pallets”
  - Grew to 2800 contractor personnel with four GS warehouses and retrograde point added

Recommendation

- Establish and resource at least two active duty Theater Distribution Centers to provide an initial capability and consider potentially one per theater (G-3, TRADOC, and G-4)

Theater Distribution Center assigned to Joint Logistics Commander



Command of Intra-Theater Transportation

The Problem

- The benefits of a command element for intra-theater transportation elements has not been realized except for the Air Force

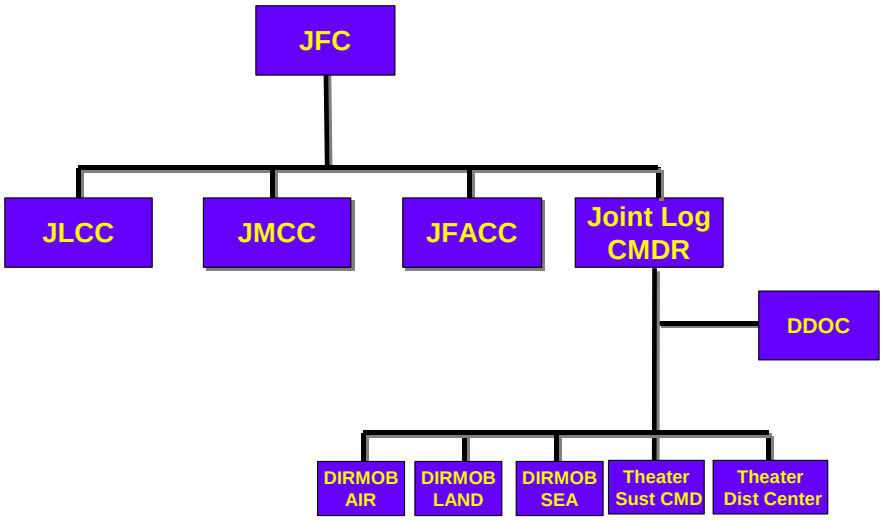
Finding

- Director, Mobility Forces (DIRMOBFOR)
  - Established from Air Mobility Command assets
  - Provides common user, intra-theater airlift
  - Controls all Air Force transportation assets, schedules all airlift missions in theater
  - Does not control Marine Corps C-130 airlift aircraft
  - Reports to the Air component commander

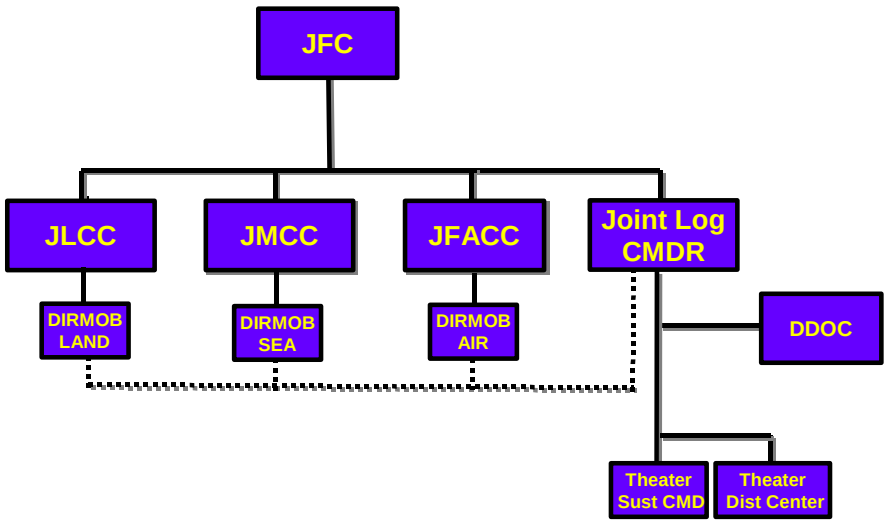
Recommendations

- In developing the Joint Theater Sustainment Command, the Army should recommend the placement of the DIRMOBFOR under the Joint Theater-level Logistics Commander or with tactical command by him (G-3 and G-4)
- The Joint Theater-level Logistics Commander should establish DIRMOBFOR-like commands for control and scheduling of all intra-theater sealift and ground transportation assets (G-4)

Assignment of Intra-theater Transportation to the Joint Theater-level Logistics Commander



Alternative Assignment of Intra-theater Transportation with Tactical Command by the Joint Logistics Commander



Supply Sustainment Practices with Potential Army Application

Findings

- Naval peacetime deployments have resulted in operating hubs, and they routinely exercise the DLA sustainment contracts to resupply deployed Naval Forces

Recommendations

- Take advantage of existing regional facilities established by the Navy in theater, and use the existing DLA contract relationships to satisfy a portion of the Army initial sustainment demand (G-4)

Supply Sustainment Afloat

Problem

- The Army relied on massive use of costly strategic airlift assets during OIF

Findings

- Cost savings and efficiency of throughput volume and tonnage capacities of a surface supply pipeline not realized
- Marine Corps
  - Currently carries initial sustainment in amphibious ships and MPF ships
  - MPF (Future) ships add additional capabilities to carry, selectively offload, and replenish sustainment material from the Sea Base
- Army
  - APS-3 has provided a sustainment capability
  - Army Regional Flotilla (ARF) concept will enhance that capability
  - Adding a Joint Warehouse Ship, operating like a DLA stock point, would further enhance sustainment and provide the first increment of a surface supply pipeline

Recommendations

- As part of the joint logistics process, collaborate with DLA and the other services to develop a Joint Warehouse Ship concept and acquire sufficient Warehouse Ships to provide initial sustainment (G-4, ASAALT, and G-8)

Repair in Theater or Afloat

Problem

- Lack of sufficient in-theater GS maintenance capability and lack of an effective process for retrograde of inoperable reparables has resulted in extended repair turnaround times and the build up in theater of dead lined material

Findings

- When Navy and Air Force units deploy, they identify a retrograde path for unserviceable repairable items
- USAF has established Centralized Intermediate Repair Facilities (CIRF) in theater and uses existing CIRFs in Europe
- USN routinely visits ports for contracted periodic maintenance with commercial ship repair facilities
- USMC maintains two Aviation Support Base ships in the ready reserve fleet to support the aviation intermediate repair requirements during MEF sized deployments

Repair in Theater or Afloat (Cont)

Findings (Cont)

- The Army has established AMC forward repair activities with limited component repair capabilities
- GS repair afloat considerations
  - Establishing Army GS repair afloat gains synergy, especially in terms of force protection, when operating as part of Navy Joint Seabasing concept
  - Repair procedures should be limited to components because neither space nor transportation would be available to bring end items aboard

Recommendations

- The Army should implement a retrograde policy for reparables similar to that in place with the Navy and the Air Force to avoid build up in theater of items requiring depot level repair (G-4)
- Establish a GS repair capability in theater...not as part of the theater opening package but as a sustaining element (AMC/G-4)
- Evaluate existing USN/USAF repair facilities in theater and assess the potential to accommodate Army repair requirements in them (AMC/G-4)
- Participate actively with Navy in developing Joint Seabasing CONOPS (G-4)
- Do a cost/benefit analysis of providing GS repair capability afloat (G-4)

In-transit Visibility Practices of Other Services

Findings - Cargo Movement Operations System (CMOS)

- **Air Force:** Developed transportation movement information system to be used in both peace and war, with links to Global Transportation Network.
  - Fielded at 200+ shipping sites. Deployable version exists
  - Provides initial training and help desk support
  - Ongoing dialogue with CENTCOM staff concerning CMOS for Theater Distribution Center and Corps Distribution Center in Iraq
- **Marine Corps:** Fielded at 14 active duty sites (CONUS and overseas); testing software for implementing at all Reserve sites
- **Navy:** Fielded at 6 overseas locations and Naval Air Station Norfolk
- **Army:** Successfully using CMOS as the European Theater Distribution Center system of record and 21st Theater Support Command is evaluating use at other sites

Recommendation

- Take advantage of an investment already made by the Air Force in Cargo Movement Operations System (CMOS) rather than developing a separate Army transportation movement information system, expedite completion of current assessment of CMOS, and direct PM-TCAIMS-II to develop an implementation plan to field CMOS Army-wide (G-4, PM-TCAIMS-II, G-8)

Army/Land Component Logistics Force Structure

The Problem

- The Army component assumed, and received, the responsibility for most of both the theater and land component opening and sustaining force requirements. As a result, the Army/LCC assumes tasks that are joint in nature but that have no effective joint logistics command and control

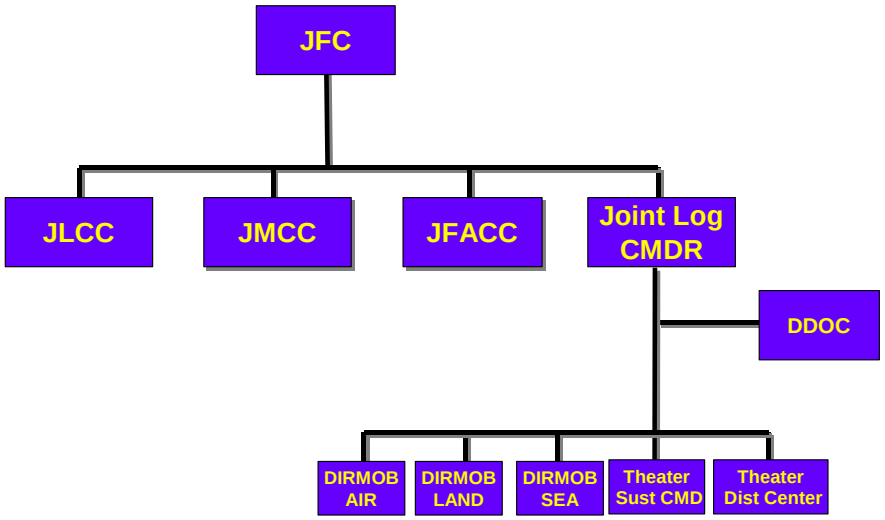
Findings

- Once the designation of units performing joint functions has been made, no new Army force structure is required to perform logistics functions for the Army component commander
- The Army component opening capability should be a subset of existing logistics organizations. The land component opening packages need to be developed and deployed concurrently with the joint theater opening package

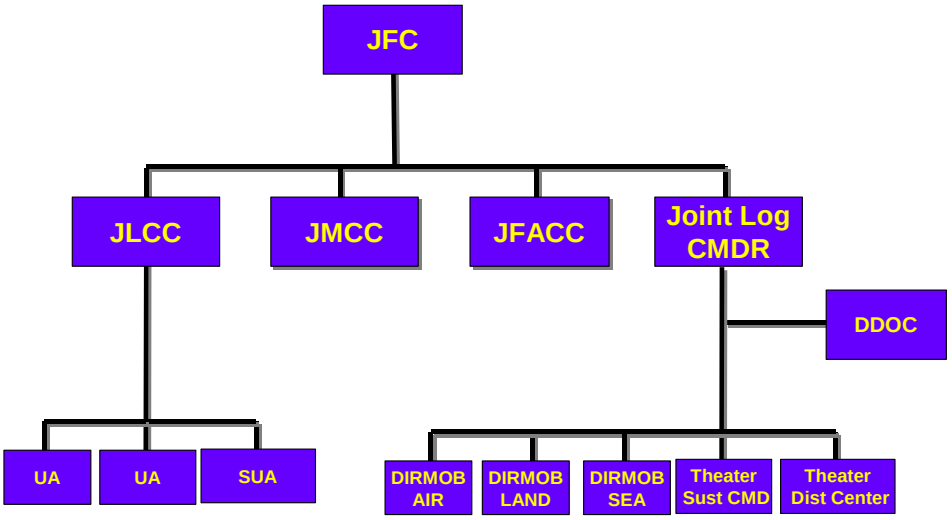
Recommendation

- Designate the portion of the Army Component Command/Land Component Command logistic structure that needs to deploy with the Joint Force opening forces to interface with it and commence early operations (TRADOC with G-4/G-3)

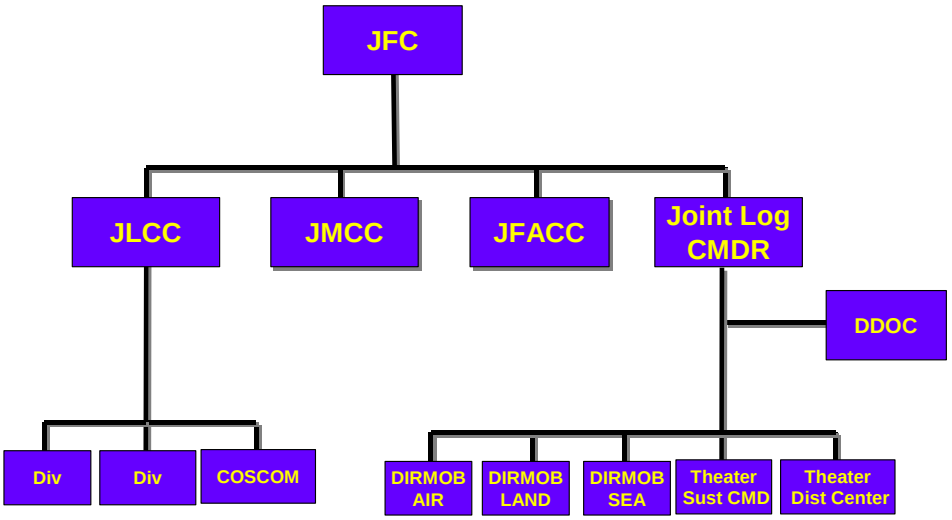
Army/Land Component Logistics Force Structure



Army/Land Component Logistics Force Structure



Army/Land Component Logistics Force Structure



Alternative Brigade Designs
Impact on Theater Sustainment Requirements

Problem

- The logistics capability of different BDE structures differ and create unique support requirements for their higher echelon sustainment organizations

Findings

- Different BDE structures have different organic logistics capabilities
- The sources of back up support (non-organic) to these different type BDEs differ

Recommendations

- Review and modify various BDE/UA designs to standardize organic logistics capabilities (TRADOC)
- Design Sustainment UAs to accommodate BDE/UA LOG capabilities shortfalls (TRADOC)

Air Force Agile Combat Support

Findings

- Air Force developed support provider packages
  - Modular, scaleable, and built from the bottom up based on the numbers and types of aircraft/platform they support
  - Integrated into each deploying Air Expeditionary Force
- Army deploys by unit rather than by platform

Recommendation

- Apply a bottom up analytical technique, similar to the USAF Agile Combat Support methodology to determine required non-organic support elements. Tie to identifiable combat units with a goal of providing scaleable and modular combat support elements that are automatically associated with the various combat elements being developed in the evolving Modular Brigades (TRADOC)

Early Use of LOGCAP

The Problem

- Precluding the availability of initial LOGCAP personnel deprives the Army of critical services

Findings

- Logistics Civilian Augmentation Program (LOGCAP)
  - Provides civilian contractors for CS/CSS services
  - Includes USAR LOGCAP Support Unit (about 100 officers) to interface between operators and contractors - mobilization complicated
  - AMC deployed Team LOGCAP Forward (planners, contracting officer and contractor liaison) during early entry
  - Does not reduce the need for early entry military personnel for theater opening and RSOI
- 2400 LOGCAP personnel in Kuwait in Dec 02; 3000 at start of OIF in Feb 03.
  - A Corps Support Group (5 battalions -- about 3000 personnel) would be needed to provide equivalent support

Recommendations

- Do not replace available LOGCAP capabilities with AC units (G4)
- Have LOGCAP in place, and allow early deployment of Team LOGCAP Forward to begin contract execution (AMC)
- Provide for rapid mobilization of LOGCAP Support Unit (AMC)

Second Topic: RFIDs and Asset In-Transit Visibility

- Tracking Technologies and IT
- Commercial vs DoD RFID Applications
- RFID Policy
- RFID Implementation

Tracking Technologies and IT

Linear Bar Code

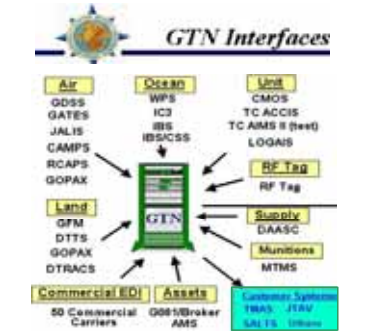
Bar codes normally store 17-20 alphanumeric characters and are used to identify items. Can be referenced to price and other inventory data. Read only.

2D Symbol

Carry 100 times (about 1500 characters) more data than a linear bar code and are readable even when part of it has been damaged.

Optical Memory Card

Can store up to 2.8 MB of useable data, and is disposable. Uses WORM (Write Once Read Many) technology. Used by DLA.

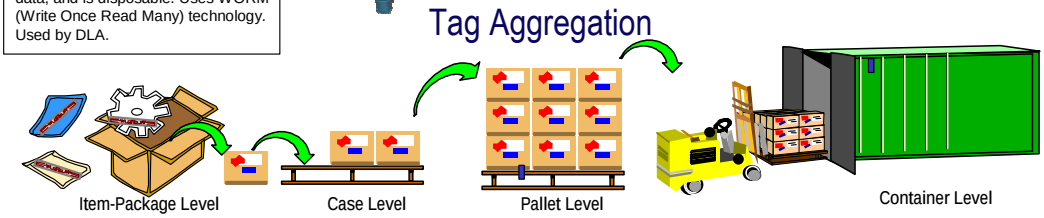


RFID - Active Radio Frequenc ID

Up to 128 Kilobytes. Can be retrieved from distances of up to 300 feet away.

RFID- Passive Radio Frequency ID

Up to 64 bits of information. Differs from active tags by requiring external activation which generates sufficient power to transmit a return signal. Read range 9 feet.



Commercial vs DoD RFID Applications

The Problem

- DoD RFID policy is diverging from the likely business path of its commercial partners, technology, users and business systems

Findings

- DoD wants detailed container/463L pallet content data on active RFID tags
- Industry wants only container ID, content monitoring or security information
- Very limited commercial use of active RFID technology to track the movement of transportation assets (trucks, trains, or ships) and almost non-existent on containers
- Passive RFID beginning to be employed commercially to facilitate highly automated warehouse processes

Recommendations

- The Army and DoD should purchase only industry-common RFID tags (PM-AIT, G-4, G-8)

RFID Policy Flaws

The Problem

- Because DoD RFID policy was developed outside of any business or process model, RFID implementation is confused, and without clear purpose or ownership.

Findings

- While DoD supply and transportation systems are functionally co-dependent, RFID policy treats them independently
- DoD policy
  - Two-tier RFID, the readings from which will become “transactions of record”
    - Active RFIDs for distribution process (owned by TRANSCOM) - point of issue to using SSA or unit
    - Passive RFIDs for receiving, shipping and inventory management in lieu of optical cards, mandated after Jan 07
  - Fails to relate application of active vs passive RFID tags to the role of bar codes

Recommendation

- DoD and the Army should together conduct a thorough business case and cost/benefit analysis of the joint supply and transportation system, to include the requirement for interoperable IT systems, prior to any further purchase, implementation, or reconfiguring of RFID (G-4 with OSD AT&L and TRANSCOM)

RFID Implementation

The Problem

- Lack of a clear business model for RFID implementation has undermined development of a BOIP, TTP, training, and discipline and has led to ineffective and inefficient implementation

Findings

- GAO Findings
  - Inadequate visibility
  - RFID tags - not used in a uniform and consistent manner
  - DOD’s logistics and asset visibility (IT) systems were not fully interoperable, capable of exchanging information, or transmitting data over required distances
  - Personnel lacked training on using RFID tags and other tracking tools
- RFIDs have not become institutionalized:
  - No units designated to employ RFID and interrogators
  - No RFID BOIP or RFID-related TTPs
  - No unit training in the use of RFID
  - No incentive or disincentive for use, nonuse, or support of RFID implementation

Recommendations

- Based on business case and cost/benefit findings, develop funded BOIP, TTPs, and training programs for RFID (TRADOC, PM-AIT, G-3, G-4, G-8)

Third Topic: Water Production, Storage, Transport, and Chilling on the Battlefield

- ROWPU vs Bottled Water
- COTS Water Purification Solution
- Water Treatment and Distribution Systems
- Future Water Production Technologies

ROWPU vs. Bottled Water

Problem

- Need a lot of water
  - Approximately 140 M bottles (over 50 M gal) of water provided by bottle
  - Minimum an additional 88 M gal needed in bulk
- Providing bottled water created a critical transportation challenge

Findings

- Bottled water
  - Easy to store on vehicles – beneficial early in operation
  - Stressed transportation
    - Required 65% of total distribution trucks daily for a 7-day convoy loop
    - Exceeded TOE transport capability by 50%
- ROWPU water
  - Purification protects soldiers, tastes like chlorine, smells bad
  - Technology exists to fix ROWPU water and reduce dependency on bottled water
    One example - MIOX technology
    - Can be integrated into ROWPU. Tastes and smells good
    - Magic-marker size purifier for individual soldier

Recommendations

- Integrate new water purification technology into new ROWPU units (PM Force Provider)
- Purchase individual purifiers as part of soldier enhancement program (PEO Soldier)
- Investigate bottling water from ship board desalination systems as a required function in the Joint Warehouse Ship (G4)

COTS Water Purification Solution - MIOX

Technology Description:

- MIOX electrolytic disinfection process to replace chlorine disinfectants
- DARPA Developed
- Prototypes tested at independent laboratories demonstrating removal of bacteria, viruses, and protozoan cysts
- More effective and eliminates the need to transport and store hazardous chemicals

Versions:

- Miniaturized version (3.5oz) fits in a "pen" or "cap"
  - Commercially sold
  - In the GSA catalog
  - Being purchased by USMC
  - Accepted as a Soldier Enhancement Program (SEP) candidate
- Large-scale system
  - Approved by EPA for municipal water treatment facilities
  - Prototype fabricated for 3,000 GPH ROWPU undergoing testing at TARDEC

Pocket

Camelbak

ROWPU

Water Treatment and Distribution Systems

New water treatment systems
(Reverse osmosis; Microfiltration)

Tactical Water Purification System (TWPS)
1,500 GPH

Lightweight Water Purifier (LWP)
120 GPH

New water distribution systems

Hippo - LHS Water Tankrack System 1500G

Camel - Unit Water Pod System 900 G

Findings

- Smaller footprint and less consumables required for generation
- Hippo eliminates safety issue and frees up transportation assets; Camel provides chilled water to the soldier

Recommendations

- Introduce technology to reduce chlorine from the ROWPU process (TARDEC/PM Force Provider)
- Procure the new water treatment (with new purification technology) and distribution systems (PM Force Provider) and align fielding plan to support Army modular initiative (G-3, TRADOC)

Future Water Production Technologies

Findings

- Foreign Alternatives
  - Following the US lead on ROWPU technology
  - Canadian forces - some interesting packaging approaches
- Alternative Sources for water
  - From Vehicular Exhaust (TRL 6; 9 cubic ft; 300 pounds)
    - Not correlated with usage requirement – requires storage
    - Storage may contribute to survivability solution (increased ballistic protection)
  - From Air (Less than TRL 6)
  - Filtering
    - Inorganic membrane process (Greater than TRL 6). Scaling is the challenge
    - Reversible wetting in nanopores (Less than TRL 6). Tested at 1.3 liters/day

Recommendations

- Pursue development of water from alternative sources (TARDEC)
- Pursue alternative water packaging initiatives (G4)

LexCarb Water Purification from Exhaust

Exhaust condensate | **Particle Filtered Water** | **Carbon/Resin Purified Water**

Study Topic

Summary of Recommendations

Don’t Do Dumb Things

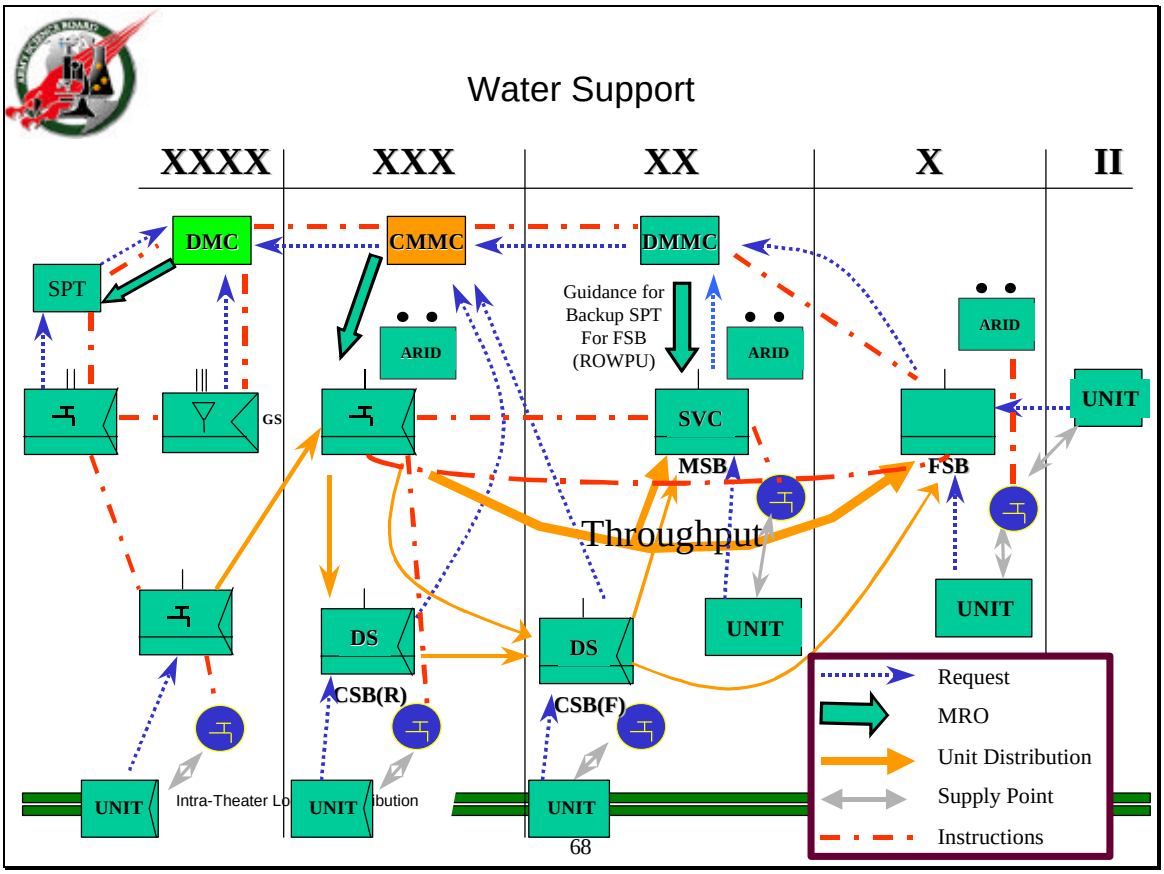
- Do not expect to conduct theater-level distribution with inadequately trained personnel
- Do not expect to command and control without communications
- Do not ship supplies to multiple customers in single containers (Pure Pack)

SUMMARY OF RECOMMENDATIONS

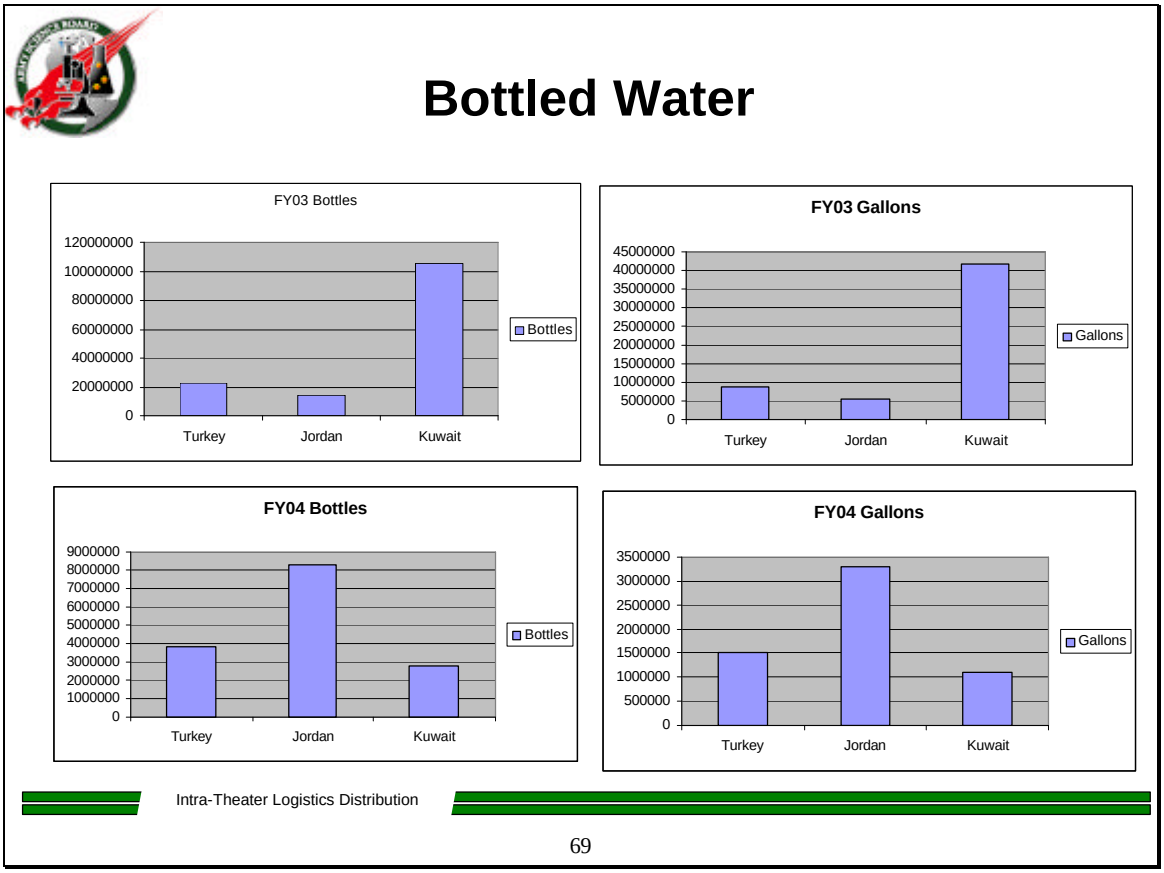
- Doctrine and Structure
  - Codify in joint doctrine the distinction between joint theater level logistics and land component/Army logistics requirements and the need for a joint theater-level logistics commander
  - Develop a Joint Theater Sustainment Command for assignment to CoCOMs
- Implement useful practices of other services
- Don't preclude early use of LOGCAP
- Complete a thorough business-based cost/benefit analysis of RFID before spending more money on it
- Fix the chlorination problem of ROWPU water

Appendix E

Water Requirements, Distribution, and Emerging Technologies



This chart shows how water is purified and distributed in the theater and the units involved.
CMMC: Corps Material Management Center
GS: General Support
CSG: Corps Support Group
CSB, R, F: Corp Support Battalion, Rear, Forward
DMMC: Division Material Management Center
MSB: Main Support Battalion
DASB: Division Aviation Support Battalion
FSB: Forward Support Battalion
MRO: Material Release Officer

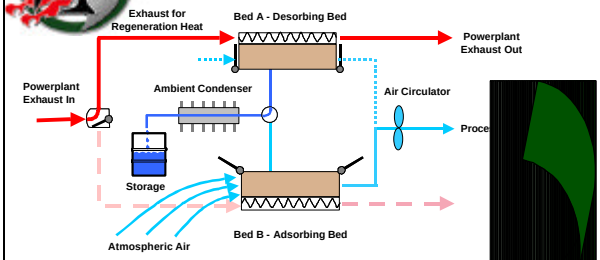


During OIF the use of bottle water increased dramatically for several reasons.
Soldiers prefered the taste
It facilitated storage aboard the combat platforms
It was readily available

Taste for ROWPU produced water is driven by the requirement for a chlorine residual up through time of consumption.

Local commercial production facilities are inspected once each year. This inspection currently consists of removing one case per lot and conducting the test. Water was obtained in Turkey, Jordan and Kuwait. The per case cost for water was in the $3 to $4 range or less than $.50 per bottle.

Other technologies ***Water Recovery & Generation***



Milestone (FY)	04	05	06	07
Evaluation DARPA technology & proof of concept for new approaches	3			
Develop & test promising technologies in lab environment	4			
Devlop & test technologies in simulated environment		5		
Design, fabricate, & test prototype in simulated environment			6	

Purpose:

- Develop the capability to produce drinking water from systems embedded in combat platforms by harvesting water from humidity sources including the atmosphere & crew compartments – reduce the large water logistics footprint

Product:

- Lightweight, energy efficient device to generate water from air for small units or platform integration

Payoff:

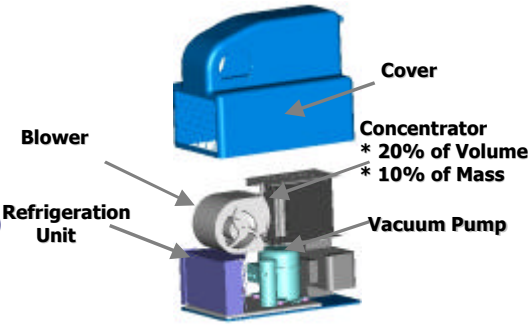
- Reduces weight of water or water sustainment equipment to deploy and carried by the soldier by 50 to 66%
- Enables soldiers/systems/units to operate without resupply for 72 hours
- Reduces logistical footprint and water distribution requirement
- Transitions to PM FCS, PAWS, HTV and/or Soldier in FY08

The next series of slides addresses other technologies with respect to water generation and recovery. The charts layout the status of the technology and where it is in the development cycle.

Water From Air

Concept

- Harvest water from air in any environment
- Apply in controlled spaces, integrate into systems, or as stand-alone unit generators



Benefits

- Provide platform based (FCSS, OFWS, etc.) and small unit stand alone water production capability
- Condensed water is relatively pure
- Independence from water distribution, source & fuel consumption
- Reduces water storage requirements
- Water in air is the most uniformly distributed water source around the world

Limitations

- Water is well distributed but has a dilute concentration in air
- Water vapor is limited in cold environments

Barriers

- Energy associated with condensation
- Energy requirements increase as concentration decreases
- Size and weight associated with conventional approaches

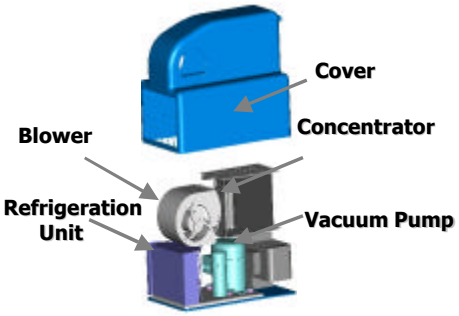
As indicated earlier in this report water from air is a technology that is being pursued. This chart presents the details of this technology concept.

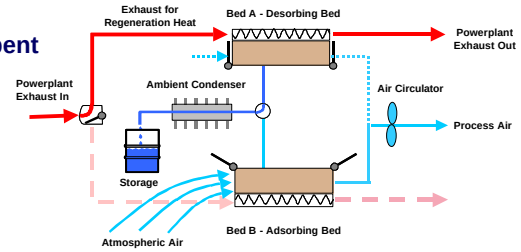
Water From Air (Continued)

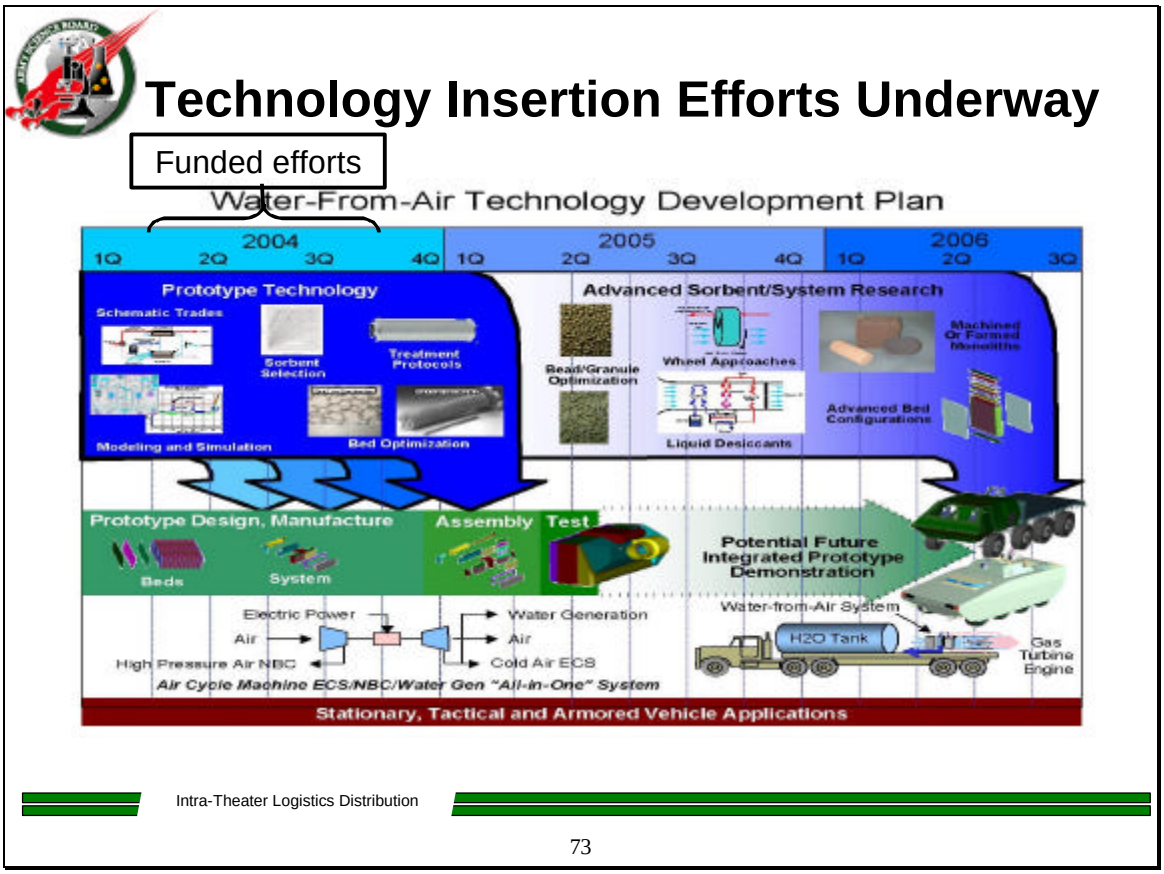
Program Description & Objective:
Demonstration of a system to recover water from air that may be used for stand alone water production or integrated into military systems

Status:
- **Laboratory testing of surface modified activated carbon validated concept**
- **New project initiated based on facilitated membrane transport**
- **Low energy condensation techniques: elevated pressure, refrigeration, sudden expansion**
- **Controlling the surface energy of condensing media**
- **Materials architecture**
- **BAA underway for more mature technology (adsorbent based) approach**

Rationale:
- **Produced water in Albuquerque, NM**
- **80 pounds**
- **385 cubic inches**
- **700 watts**







Technology insertion efforts for water from air are shown on this chart. The development plan shows both funded and unfunded efforts.

Other technologies *Low-Energy Production of Water from Air*

Novel Technology

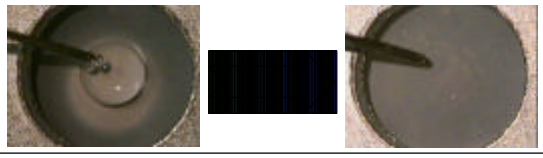
Potable water from atmospheric air without Energy-intensive refrigeration cycle.

Two approaches:

- **Variable surface chemistry (hydrophilic-hydrophobic) in nanoporous membranes with pore sizes of 2 to 20 nm, for adsorption/liquid extraction.**
- **Electric field gradient/elecro-wetting for enhanced condensation rate, transport and liquid water collection without moving parts.**
- **High-efficiency, plastic meso-scale heat-exchangers.**

Critical Technology Development Areas

- **Change the surface chemistry in nanopores from hydrophobic to hydrophilic.**
- **Graded surface energy coatings by wetting and dewetting.**
- **Practical electro-wetting electrode structures printed on surfaces to enhance condensation/water collection.**



Meeting the Phase 1 Objectives

18-month Go/No-go Milestone

- **Produce 1.5 liters/day @ 15 WHr/liter energetics from 25°C, 50% R.H. air.**

Specific Goals

- **Rapidly condense and transport water with surface energy varied by electrical energy.**
- **Move water drops at >1 cm/s with electric field gradient.**
- **Demo a plastic heat exchanger with flux of >600 W/m² with ? T of 2°C and model fluid flow for optimal water transport.**

Recent Developments

- ***Reversible* wetting in nanopores clearly demonstrated for the first time**
- **Water drop migration with velocity of >6.7 cm/s via electrowetting demonstrated.**
- **High performance, light weight plastic meso-scale heat exchanger prototype designed, fabricated, and tested at 1.3 liters/day.**

Additional water production technologies may be developed in conjunction with the Future Combat System project.

Other Technologies

ORNL's Inorganic Membrane Process

- Pore diameters of 0.5 nm to 20,000 nm
- Support structure and layer made of variety of metals and ceramics
- Mechanical, thermal, and chemical stability
- Membrane layer thickness of 2µm or less yielding a high permeance at low pressure drop
- Proven scalability

This water purification using membrane technology is currently under study at Sandia National Labs.

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